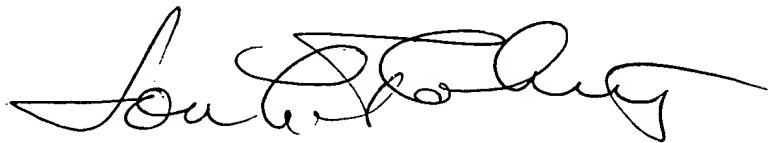


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I hereby certify that the patent application of Brian A. Rosenfeld, M.D. and Michael Breslow for a **SYSTEM AND METHOD FOR PROVIDING CONTINUOUS, EXPERT NETWORK CRITICAL CARE SERVICES FROM A REMOTE LOCATION(S)** including the specification, abstract, and claims (2 independent, 12 dependent, 14 total) (1~~18~~ pages); informal drawings (57 figures, 56 sheets); declaration and power of attorney; Verified Statement Claiming Small Entity Status - Small Business Concern; Verified Statement Claiming Small Entity status - Independent Inventor; and a check in the amount of \$380.00, are being deposited with the United States Postal Service for "Express Mail" service under 37 C.F.R. § 1.10 on the date indicated above and are addressed to the Assistant Commissioner for Patents, Box Patent Application, Washington, D.C. 20231.



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1 **Title:** **System and Method for Providing Continuous, Expert Network Critical**
2 **Care Services from a Remote Location(s)**

3
4 **Inventor:** **Brian A. Rosenfeld, M.D. and Michael Breslow**

5 **Field of the Invention**

6 This invention relates generally to the care of patients in Intensive Care Units (ICUs).
7 More particularly this invention is a system and method for care of the critically ill that
8 combines a real-time, multi-node telemedicine network and an integrated, computerized patient
9 care management system to enable specially-trained Intensivists to provide 24-hour/7-day-per-
10 week patient monitoring and management to multiple, geographically dispersed ICUs from
11 both on-site and remote locations.

12 **Background of the Invention:**

13 While the severity of illness of ICU patients over the past 15 years has increased
14 dramatically, the level of and type of physician coverage in most ICUs has remained constant.
15 Most ICU patients receive brief minutes of attention during morning rounds from physicians
16 with limited critical care experience. During the remainder of the day and night, nurses are the
17 primary caregivers, with specialists called only **after** patient conditions have started to
18 deteriorate. The result of this mismatch between severity of illness and physician coverage is
19 an unacceptably high ICU mortality rate (10% nationwide), and a high prevalence of avoidable
20 errors that result in clinical complications. In 1998, an Institute of Medicine Roundtable
21 determined that avoidable patient complications were the single largest problem in medical care
22 delivery. In another prominent 1998 study of 1000 patients, 46% experienced an avoidable
23 adverse event in care, with 40% of these errors resulting in serious disability or death.

1 The physicians who can remedy this situation are in critically short supply. Numerous
2 studies have shown that Intensivists (physicians who have trained and board certified in Critical
3 Care Medicine) can markedly improve patient outcomes. However, only one-third of all ICU
4 patients ever has an Intensivist involved in their care, and the number of Intensivists would
5 need to increase tenfold (nationally) to provide 24-hour coverage to all ICU patients. With the
6 rapid aging of the population, this shortfall of expertise is going to increase dramatically.

7 Even where Intensivists are present (and especially where they are not), patients suffer
8 from unnecessary variation in practice. There is little incentive for physicians to develop and
9 conform to evidence-based best practices (it takes significant work and a change in behavior to
10 develop and implement them). This variation contributes to sub-optimal outcomes, in both the
11 quality and cost of care delivered to ICU patients.

12 What is needed is a redesigning of the critical care regimen offered to patients in an
13 ICU. Rather than the consultative model where a periodic visit takes place and the doctor then
14 goes away, a more active 24-hour intensivist managed care is required. Further, technology
15 that leverages the intensivists' expertise and standardizes the care afforded to patients in an ICU
16 is required. Further, continuous feedback to improve the practice of intensivists in an ICU is
17 necessary to provide the intervention required to minimize adverse events. This invention
18 seeks to provide new methods for managing and delivering care to the critically ill.

19 Attempts to automate various aspects of patient care have been the subject of various
20 inventions. For example, U.S. Patent No. 5,868,669 to Iliff was issued for "Computerized
21 Medical Diagnostic and Treatment Advice System." The disclosed invention is for a system

and method for providing computerized knowledge based medical diagnostic and treatment advice to the general public over a telephone network.

U.S. Patent No. 5,823,948 to Ross, Jr. et al was issued for "Medical Records Documentation, Tracking and Order Entry System". The disclosed invention is for a system and method that computerizes medical records, documentation, tracking and order entries. A teleconferencing system is employed to allow patient and medical personnel to communicate with each other. A video system can be employed to videotape a patient's consent.

U.S. Patent No. 4,878,175 to Norden-Paul et al. was issued for “Method for Generating Patient-Specific Flowsheets By Adding/Deleting Parameters.” The disclosed invention is for an automated clinical records system for automated entry of bedside equipment results, such as an EKG monitor, respirator, etc. The system allows for information to be entered at the bedside using a terminal having input means and a video display.

U.S. Patent No. 5,544,649 to David et al. was issued for "Ambulatory Patient Health Monitoring Techniques Utilizing Interactive Visual Communications." The disclosed invention is for an interactive visual system, which allows monitoring of patients at remote sites, such as the patient's home. Electronic equipment and sensors are used at the remote site to obtain data from the patient, which is sent to the monitoring site. The monitoring site can display and save the video, audio and patient's data.

U.S. Patent No. 5,867,821 to Ballantyne et al. was issued for “Method and Apparatus for Electronically Accessing and Distributing Personal Health Care Information and Services in Hospitals and Homes.” The disclosed invention is for an automated system and method for

1 distribution and administration of medical services, entertainment services, and electronic
2 health records for health care facilities.

3 U.S. Patent No. 5,832,450 to Myers et al. issued for "Electronic Medical Record Using
4 Text Database." The disclosed invention is for an electronic medical record system, which
5 stores data about patient encounters arising from a content generator in freeform text.

6 U.S. Patent No. 5,812,983 to Kumagai was issued for "Computer Medical File and
7 Chart System." The disclosed invention is for a system and method which integrates and
8 displays medical data in which a computer program links a flow sheet of a medical record to
9 medical charts.

10 U.S. Patent No. 4,489,387 to Lamb et al. was issued for "Method and Apparatus for
11 Coordinating Medical Procedures." The disclosed invention is for a method and apparatus that
12 coordinates two or more medical teams to evaluate and treat a patient at the same time without
13 repeating the same steps.

14 U.S. Patent No. 4,731,725 to Suto et al. issued for "Data Processing System which
15 Suggests a Pattern of Medical Tests to Reduce the Number of Tests Necessary to Confirm or
16 Deny a Diagnosis." The disclosed invention is for a data processing system that uses decision
17 trees for diagnosing a patient's symptoms to confirm or deny the patient's ailment.

18 U.S. Patent No. 5,255,187 to Sorensen issued for "Computer Aided Medical Diagnostic
19 Method and Apparatus." The disclosed invention is for an interactive computerized diagnostic

1 system which relies on color codes which signify the presence or absence of the possibility of a
2 disease based on the symptoms a physician provides the system.

3 *all* *6/1/04* *Sub* *6/1* *U.S. Patent No. 5,839,438 to Chen et al. issued for "Intelligent Remote Visual*
4 *Monitoring System for Home Health Care Service."* The disclosed invention is for a computer-
5 based remote visual monitoring system, which provides in-home patient health care from a
6 remote location via ordinary telephone lines.

7 U.S. Patent No. 5,842,978 to Levy was issued for "Supplemental Audio Visual
8 Emergency Reviewing Apparatus and Method." The disclosed invention is for a system which
9 videotapes a patient and superimposes the patient's vital statistics onto the videotape.

10 *Sub* *6/1* *While these invention provide useful records management and diagnostic tool, none of*
11 *them provides a comprehensive method for monitoring and providing real time critical care at*
12 *disparate ICU's. In short, they are NOT designed for critical care. Further, none of these*
13 *inventions provide for the care of a full time intensivist backed by appropriate database and*
14 *decision support assistance in the intensive care environment. What would be useful is a system*
15 *and method for providing care for the critically ill that maximizes the presence of an intensivist*
16 *trained in the care of the critically. Further such a system would standardize the care in ICU's at*
17 *a high level and reduce the mortality rate of patients being cared for in ICU's*

18 **Summary of the Invention:**

19 The present invention provides a core business of Continuous Expert Care Network
20 (CXCN) solution for hospital intensive care units (ICUs). This e-solution uses network,

1 database, and decision support technologies to provide 24-hour connectivity between Intensivists
2 and ICUs. The improved access to clinical information and continuous expert oversight leads to
3 reduced clinical complications, fewer medical errors, reduced mortality, reduced length of stay,
4 and reduced overall cost per case.

5 The technology of the present invention as explained below can be implemented all at
6 once or in stages. Thus the technology, as more fully explained below is available in separate
7 components to allow for the fact that hospitals may not be able to implement all of the
8 technology at once. Thus modular pieces (e.g. videoconferencing, vital sign monitoring with
9 smart alarms, hand-held physician productivity tools, etc.) can be implemented, all of which can
10 add value in a stand-alone capacity. First amongst these offerings will be an Intensivist Decision
11 Support System, a stand-alone software application that codifies evidence-based, best practice
12 medicine for 150 common ICU clinical scenarios. These support algorithms are explained more
13 fully below.

14 The "Command Center" model, again as more fully set forth below, will ultimately give
15 way to a more distributed remote management model where Intensivists and other physicians can
16 access ICU patients and clinicians (voice, video, data) from their office or home. In this
17 scenario, the present invention will be available in hospital applications that centralize ICU
18 information, and offer physicians web-based applications that provide them with real-time
19 connectivity to this information and to the ICUs. This access and connectivity will enable
20 physicians to monitor and care for their patients remotely. These products will be natural
21 extensions and adaptations of the present invention and the existing applications disclosed herein

1 that those skilled in the art will appreciate and which do not depart from the scope of the
2 invention as disclosed herein.

3 The present invention addresses these issues and shortcomings of the existing situation in
4 intensive care, and its shortfalls via two major thrusts. First, an integrated video/voice/data
5 network application enables continuous real-time management of ICU patients from a remote
6 setting. Second, a client-server database application B integrated to the remote care network B
7 provides the data analysis, data presentation, productivity tools and expert knowledge base that
8 enables a single Intensivist to manage the care of up to 40 patients simultaneously. The
9 combination of these two thrusts B care management from a remote location and new,
10 technology-enhanced efficiency of Intensivist efforts B allows health care systems to
11 economically raise the standard of care in their ICUs to one of 24x7 continuous Intensivist
12 oversight.

13 It is therefore an object of the present invention to reduce avoidable complications in an
14 ICU.

15 It is a further object of the present invention to reduce unexplained variations in resource
16 utilization in an ICU.

17 It is a further objective of the present invention to mitigate the serious shortage of
18 intensivists.

19 It is yet another objective of the present invention to reduce the occurrence of adverse
20 events in an ICU.

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1 It is a further objective of the present invention to standardize the care at a high level
2 among ICUs.

3 It is yet another objective of the present invention to reduce the cost of ICU care.

4 It is yet another objective of the present invention to dramatically decrease the mortality
5 in an ICU.

6 It is yet another objective of the present invention to bring information from the ICU to
7 the intensivist, rather than bring the intensivist to the ICU.

8 It is a further objective of the present invention to combine tele-medical systems
9 comprising two-way audio/video communication with a continuous real time feed of clinical
10 information to enable the intensivist to oversee care within the ICU.

11 It is a further objective of the present invention to allow intensivists to monitor ICUs
12 from a site remote from each individual ICU.

13 It is a further objective of the present invention to bring organized detailed clinical
14 information to the intensivist, thereby providing standardized care in the ICU.

15 It is yet another objective of the present invention to utilize knowledge-based software to
16 use rules, logic, and expertise to provide preliminary analysis and warnings for the intensivists.

17 The present invention comprises a command center/remote location, which is
18 electronically linked to ICUs remote from the command center/remote location. The command
19 center/remote location is manned by intensivists 24 hours a day, seven days per week. Each ICU
20 comprises a nurse's station, to which data flows from individual beds in the ICU. Each patient in
21 the ICU is monitored by a video camera, as well as by clinical monitors typical for the intensive

care unit. These monitors provide constant real time patient information to the nurse's station, which in turn provides that information over a dedicated T-1 (high bandwidth) line to the ICU command center/remote location. As noted earlier, the command center/remote location is remote from the ICU, thereby allowing the command center/remote location to simultaneously monitor a number of patients in different ICUs remote from the command center/remote location.

At each command center/remote location, video monitors exist so that the intensivist can visually monitor patients within the ICU. Further, the intensivist can steer and zoom the video camera near each patient so that specific views of the patient may be obtained, both up close and generally. Audio links allow intensivists to talk to patients and staff at an ICU bed location and allow those individuals to converse with the intensivist.

Clinical data is constantly monitored and presented to the command center/remote location in real time so that the intensivist can not only monitor the video of the patient but also see the vital signs as transmitted from the bedside. The signals from the clinical data and video data are submitted to a relational database, which comprises 1) standardized guidelines for the care of the critically ill, 2) various algorithms to support the intensive care regimen, 3) order writing software so that knowledge-based recommendations and prescriptions for medication can be made based upon the clinical data, and 4) knowledge-based vital-sign/hemodynamic algorithms that key the intensivist to engage in early intervention to minimize adverse events.

The advantage of the present invention is that intensivists see all patients at a plurality of ICU's at all times. Further, there is a continuous proactive intensivist care of all patients within

the ICU, thereby minimizing adverse events. Intervention is triggered by evidence-based data-driven feedback to the intensivist so that standardized care can be provided across a plurality of ICUs.

The economic benefits of the present invention are manifold. For the first time, 24-hour a day, seven day a week intensivists care for patients in an ICU can be obtained. Further, more timely interventions in the care of the patients can be created by the knowledge-based guidelines of the present invention, thereby minimizing complications and adverse events. This in turn will lead to a reduced mortality within the ICU, and hence, a reduced liability cost due to the dramatic reduction in avoidable errors in health care.

By providing timely interventions, the length of stay within the ICU can be greatly reduced, thereby allowing more critically ill patients to be cared for in the ICU.

In addition, by reviewing and standardizing the care afforded to patients in an ICU, a more standardized practice across a variety of ICUs can be achieved. This will lead to more cost-effective care within the ICU, and reduced ancillary cost for the care of the critically ill.

The overall architecture of the present invention comprises a "pod." The pod comprises a tele-medicine command center/remote location connected to a plurality multiple ICUs at various locations. The connection between the command center/remote location and the ICUs is via a dedicated wide-area network linking the ICUs to the command center/remote location and a team of intensivists who integrate their services to provide 24-hour, seven day a week care to all of the pod ICUs.

The pod is connected via a wide-area network using dedicated T-1 lines, for example, with redundant backup. This network provides reliable, high speed secure transmission of clinical data and video/audio signals between each patient room and the command center/remote location. The use of a T-1 line is not meant as a limitation. It is expected that more and higher bandwidth networks will become available. Such high bandwidth networks would come within the scope of the invention as well.

Each patient room is equipped with a pan/tilt/zoom video camera with audio and speaker to enable full videoconferencing capability. In addition, computer workstations are dedicated for exclusive physician use in each ICU, preferably at the nurse's station. Intensivists use the workstations to view patient information, consult decision support information, record their notes, and generate patient orders.

The patient management software used by intensivists is provided across the pod. Updates and changes made to the record are available at both the ICU and the command center/remote location for any given patient.

Each command center/remote location contains at least three workstations: one for the intensivist, one for the critical care registered nurse, and one for a clerk/administrative person.

The intensivist workstation comprises separate monitors for displaying ICU video images of patients and/or ICU personnel, output from bedside monitoring equipment, patient clinical data comprising history, notes, lab reports, etc., and decision support information. The staff at the command center/remote location are able to activate and control the cameras in each patient's room so that appropriate visual views of the patient can be generated.

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1 Intensivists are able to switch between rooms and patients and can monitor at least two
2 rooms simultaneously via the video screens. Patient data such as X-ray and ECG images are
3 scanned and transmitted to the command center/remote location upon request of the intensivist.

4 Remote patient management is utilized in the present invention's critical care program to
5 supplement traditional onsite care. The rationale underlying the remote patient management of
6 the present invention is that critically ill patients are inherently unstable and require continuous
7 expert care that is not now offered in existing ICU monitoring regimens. Further, remote
8 monitoring allows a single intensivist to care for patients in multiple ICU locations, thereby
9 creating an efficiency that makes continuous care feasible.

10 Remote intensivist care of the present invention is proactive. Intensivists will order
11 needed therapies and check results of tests and monitor modalities in a more timely fashion than
12 is currently offered. Patients can be observed visually when needed using the ceiling-mounted
13 cameras in each room.

14 Command center/remote location personnel communicate with ICU staff through
15 videoconferencing and through "hot phones," which are dedicated telephones directly linked
16 between the command center/remote location and the ICU. These communications links are
17 used to discuss patient care issues and to communicate when a new order has been generated.

18 Intensivists document important events occurring during their shift in progress notes
19 generated on the command center/remote location computer terminal.

1 Intensivists detect impending problems by intermittently screening patient data, including
2 both real time and continuously stored vital sign data. Patient severity of illness determines the
3 frequency with which each patient's data is reviewed by the intensivists.

4 **Brief Description of the Figures**

5 Figure 1 illustrates the logical data structure for billing, insurance and demographic
6 information

7 Figure 1A illustrates the logical data structure for billing, insurance and demographic
8 information (cont)

9 Figure 2 illustrates the command center logical data structure

10 Figure 2A illustrates the command center logical data structure (cont)

11 Figures 3 illustrates the logical data structure for creating a medical history

12 Figure 4 illustrates the logical data structure for creating notes relating to patient
13 treatment and diagnosis

14 Figure 4A illustrates the logical data structure for creating notes relating to patient
15 treatment and diagnosis (cont)

16 Figure 4B illustrates the logical data structure for creating notes relating to patient
17 treatment and diagnosis (cont)

18 Figure 5 illustrates the logical data structure for entry of medical orders

19 Figure 6 illustrates the logical data structure for patient care, laboratory testing and
20 diagnostic imaging

Figure 6A illustrates the logical data structure for patient care, laboratory testing and diagnostic imaging (cont)

Figure 7 illustrates the logical data structure for categories of information that are permitted to be presented to intensivists and other care givers by the system

Figure 8 illustrates the logical data structure for documenting patient vital signs

Figure 8A illustrates the logical data structure for documenting patient vital signs (cont)

Figure 9 illustrates the distributed architecture of the present invention

Figure 10 illustrates the system architecture of the present invention

Figure 11 illustrates the decision support algorithm for decision support algorithm for diagnosis and treatment of pancreatitis.

Figure 12 illustrates the vital signs data flow.

Figure 13A illustrates capture and display of diagnostic imaging.

Figure 13B illustrates establishing videoconferencing in the present invention.

Figure 14 illustrates the physician resources order writing data interface of the present invention.

Figure 15 illustrates the physician resources database data interface of the present invention.

Figure 16 illustrates the automated coding and billing system integrated with the workflow and dataflow of the present invention.

Figure 17 illustrates the order writing data flow of the present invention.

Figure 18 illustrates the event log flow of the present invention.

1 Figure 34A illustrates the wide complex QRS Tachycardia decision support algorithm

2 (cont)

3 *Sub*
CT Figure 41 illustrates the assessment of sedation decision support algorithm

4 Figure 41A illustrates the assessment of sedation decision support algorithm (cont)

5 Figure 42 illustrates the bolus sliding scale midazolam decision support algorithm

6 Figure 43 illustrates the sedation assessment algorithm decision support algorithm

7 Figure 44 illustrates the short term sedation process decision support algorithm

8 Figure 45 illustrates the respiratory isolation decision support algorithm

9 Figure 47 illustrates the empiric meningitis treatment decision support algorithm

10 Figure 48 illustrates the ventilator weaning decision support algorithm

11 Figure 48A illustrates the ventilator weaning decision support algorithm (cont)

12 Figure 49 illustrates the warfarin dosing decision support algorithm

13 ~~Figure 51 illustrates the HIT-2 diagnostic decision support algorithm~~

14 **Definitions of Terms and Data**

15 *Sub*
CT In the following Detailed description of the Invention, a number of modules and
16 procedures are described. For purposes of definitions, the following module definitions apply
17 and are more fully amplified in the descriptions of the figures that follow:

18 **Term Definitions:**

19 Following are a series of definitions for certain terms used in this specification:

20 Insurance carrier: This is a table of all the valid insurance carriers listed in the system of
21 the present invention.

1 Patient guarantor: Provides the insurance guarantor information for a given patient. \

2 Patient information: Provides demographic information for each patient.

3 Medical event date history: This contains the various disorders of the patient and the
4 dates associated with major medical events relating to those disorders.

5 Medical history: Contains non-major system medical history of a patient.

6 Drug: Contains what medication and allergies have been identified for a patient at
7 admission.

8 Address: Contains the address or addresses for a given patient.

9 Patient visit: There may be multiple records for any given patient, since the patient may
10 visit the ICU on more than one occasion. This file contains a record of each visit to an ICU by a
11 patient.

12 Physician-patient task: Contains the task that had been defined for each patient.

13 Present illness: This contains a textual description of the patient illness for the specific
14 ICU visit.

15 Physical exam: This contains the information gathered as a result of a physical
16 examination of the patient during the admission to the ICU.

17 Surgical fluids: This provides all the information related to the fluids provided during
18 surgery.

19 Surgery: This contains all information pertaining to any surgical procedure performed on
20 a patient while the patient is at the ICU.

1 Command center/remote location definitions and modules have also been created for the
2 present invention to allow for the orderly storage and retrieval and entering of data. For
3 example:

4 Physician-physician (such as nurses and LPN and the like): Contains the names of all of
5 the physicians and physician extenders for the command center/remote location as well as for
6 ICUs associated with the command center/remote location.

7 Communication: Contains all of the various types of communication vehicles used to
8 contact an individual physician or physician extender.

9 Physician role: Contains the role a physician is playing for a given patient, (i.e., primary
10 care, consultant, etc.)

11 Patient: Provides demographic information for each patient.

12 Command center/remote location: Provides identifying information for a particular
13 command center/remote location.

14 Hospital: Contains identifying information for a particular hospital wherein an ICU is
15 located.

16 ICU: Contains identifying information for an ICU at a hospital.

17 ICU bed: Contains the association for identifying which beds are in a given hospital.

18 ICU patient location: Provides the association between an ICU and a patient and
19 identifies where a patient is located within an ICU in a particular hospital.

1 The order entry functionality of the present invention provides a critical service for
2 obtaining information on the patient during admission, medical orders, and procedures provided
3 to the patient during the ICU stay. For example:

4 Radiology: Contains all radiology performed on a particular patient.

5 Radiology results: Contains the results of each radiology test performed on the particular
6 patient.

7 Drugs: Contains all relevant information for all the drugs that a patient has been
8 administered.

9 Laboratory: Contains all laboratory tests ordered for a patient.

10 Microbiology result: Contains the results of microbiology organisms taken on a patient.

11 Laboratory result: Contains the results for a laboratory test ordered for a particular
12 patient.

13 **Detailed Description of the Invention**

14 The present invention is a system and method for remote monitoring of ICU's from a
15 distant command center/remote location. By monitoring a plurality of ICU's remotely,
16 intensivists can better spread their expertise over more ICU beds that heretofore achievable. The
17 presence of 24-hour a day/7 day-per-week intensivist care dramatically decreases the mortality
18 rates associated with ICU care.

19 Referring to Figures 1 and 1A, the Billing and Demographic data structure of the present
20 invention is illustrated. Patient demographic information 9010 is collected on the particular
21 patient. This information comprises all the typical kinds of information one would normally

1 regarding the ID that is given to a particular physician by each insurance provider. This
2 information is also stored and can be associated ultimately with treatment of the patient.

3 Each patient admitted to the hospital and to the ICU has a patient visit ID associated with
4 the patient **9017**. This visit ID has patient ID information, ICU information, admission date, and
5 other information relevant to the specific visit. This information is illustrated in Figure 1A. The
6 visit ID **9017** is associated with the patient ID **9010** so that each visit can be tracked by patient.

7 Insurance carrier information **9018** is stored by the system and is associated with the
8 insurance plan information **9008** as appropriate. Thus the particular insurance carrier with its
9 name, address, and other identifying information **9018** is associated with the type of plan **9008**
10 carried by the patient. The insurance carrier information **9018** together with the insurance plan
11 information **9008** is associated with the patient via the patient ID information **9010**.

12 Patient address information **9020** and **9022** are collected for each individual patient and
13 associated with the patient demographic information **9010**. If there is a patient guarantor, this
14 information is obtained and stored with information on the guarantor **9026**. Such information as
15 the guarantor's first and last name, date of birth, and other information is stored and is illustrated
16 in Figure 1A. Further, the guarantor's address **9024** is also collected and ultimately associated
17 with the patient demographic information **9010**.

18 Referring to Figures 2 and 2A, the Command Center logical data structure is illustrated.
19 The various information associated with demographic and insurance information is again used to
20 manage the care and operations of the command center. Therefore, communications information
21 **9000** is combined with physician and physician extender (i.e. nurse, LPN and the like)
22 information **9002** and physician role **9004** to be associated with the demographic information
23 **9010**. The patient visit information **9017** together with this information is associated with the

1 patient's location which has a unique identifier **9030**. Each location ID has patient ID
2 information and visit ID information associated with it.

3 Referring now to Figure 2A, the Command Center logical data structure illustration
4 continues. Each ICU bed has an associated location ID which comprises hospital ICU
5 information, room number, and bed number **9038**. In addition, and as described earlier,
6 instrumentation such as cameras are also associated with the particular patient. Therefore the
7 camera setting **9040** will have a location ID relating to the ICU bed as well as have camera value
8 settings and associated camera identifier information.

9 Each ICU bed **9038** is associated with an ICU **9032**. Each ICU has information
10 associated with it that uniquely identifies the ICU as being associated with the particular
11 hospital, and having particular phone numbers, fax numbers, work space addresses, and other
12 information, that help to identify the ICU.

13 As noted above, each ICU is associated with a hospital **9034**. Each hospital has a unique
14 identifier, as well as its own name, address, and other identifying information. Further, since
15 each hospital ICU is to be coordinated through a remote command center, information on the
16 remote command center **9036** is associated with the hospital information. Each command center
17 has a unique ID and has associated address information stored as well.

18 Thus in the Command Center logical data structure, patient ID information **9010** is linked
19 to a patient location **9030** which in turn is associated with an ICU bed **9038** each of which beds
20 are uniquely associated an ICU **9032** which is associated with a hospital **9034** which in turn has
21 the ICU managed by a command center **9036**.

22 An integral part of the system of the present invention is the recording of medical history.
23 Referring to Figure 3, the logical relationship among data elements for medial history is

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1 illustrated. Patient visit information **9017** combined with the physician-physician extender
2 information **9002** is combined with specific note-taking information **9042**. The note information
3 comprises the date and time the notes are taken as well as the note type. The note ID is fed
4 information from the medical history item **9044**, which has its own unique medical ID associated
5 with it. This information comprises medical text, category of information, and other information
6 relevant to the medical history. As noted, this information for medical history **9044** is associated
7 with a note ID **9042**, which in turn is associated with the patient visit and physician information
8 **9017** and **9002**.

9 Referring to Figure 4, 4A, and 4B, the note-keeping logical data structure of the present
10 invention is illustrated. As noted earlier, the note ID **9042** combines information from visit ID,
11 treating physician, and other information relating to the time the note was entered. Other
12 information is associated with the note ID. Referring first to Figure 4, the patient visit
13 information **9017**, is associated with the note ID **9042**. Various procedural information **9046** is
14 kept by the system of the present invention and is associated with the visit ID **9017**. Physicians
15 are able to create free text patient illness notations **9048** and associate them with the note **9042**.
16 Similarly, free text information regarding functioning of the system **9050** is permitted and also
17 associated with notes regarding the particular patient and procedure **9042**.

18 Specific notes regarding, for example, surgical procedures are also kept. Surgery notes
19 **9054** are associated with a particular note ID and have such information as anesthesia, surgical
20 diagnosis, elective information, and other related surgical information. Surgical fluids **9052**
21 administered during the course of surgery are associated with the surgery information **9054**.
22 Additionally, any surgical complications **9056** are noted and also associated with the surgery

1 which in turn has an associated note ID.

2 Referring now to Figure 4A, the logical data structure for notes and its description is
3 continued. An assessment plan **9058** is created and associated with the same note ID for the
4 particular patient. The plan has a free text field that allows a physician to create the appropriate
5 assessment plan and associate it with a note ID **9042**.

6 Various daily notes are also kept and associated with the individual note ID **9042**. For
7 example, the daily mental state **9060** is recorded to document the mental state of the patient. The
8 daily treatment **9062** administered to the patient is associated with the unique note ID. The daily
9 diagnosis **9068** is also created and associated with unique note ID **9042**.

10 Any unstable conditions are also noted **9070** and records kept of those conditions.
11 Similarly mortality performance measures (MPM) information **9072** is kept and associated with
12 the unique note ID. To the extent that any physical exam **9074** is administered, that physical
13 exam and any free text created by the physician is associated with the unique ID and records
14 kept. Allergy information **9076** for the particular patient is also created and stored along with the
15 allergy type, and allergy name. This information is uniquely associated with the note ID.

16 Referring now to Figure 4B, the Logical Data Structure for the Notes Creation and Storage
17 description is continued. A specific note item record **9078** is also kept and associated with
18 unique note ID. This note item comprises the principal diagnosis, the chief complaint, the past
19 history of the patient, the reason for the note, and various other identifications and flags of
20 information which help in documenting the patient's condition.

21 Any drugs that are administered to the patient, including dosage, type, and number **9086**
22 is kept and associated with the unique note ID **9042**.

1 Procedural note items are also documented **9082**. Procedural notes involve the
2 procedural type, the principal diagnosis, the procedural location, procedural indications, and
3 other information of a procedural nature. Procedural description information **9088** is kept as
4 input to the procedural note item. This information is also associated with a procedural
5 evaluation **9084** which comprises text describing the procedural evaluation that occurred, These
6 three items, the procedural description **9088**, procedural evaluation **9084**, and procedural note
7 items **9082**, are all uniquely associated with the note ID **9042**.

8 Referring now to Figure 5, the Logical Data Structure of the Medical Order Functionality
9 of the Present Invention is illustrated. Each medical order **9092** has a unique order ID associated
10 with it. This information derives its uniqueness from the visit ID, the representative ID, and
11 various information about the date in which the order was created and other such relevant
12 information. Any non-drug orders **9090** are associated with a unique non-drug order ID. The
13 order is classified, identified, and free text can be created by the physician to describe the order.
14 This information in the non-drug order **9090** is associated with the unique medical order for that
15 particular patient **9092**.

16 Again physician and physician extender identification information **9002** is also uniquely
17 associated with the medical order to identify the physician involved in creating the particular
18 order in question.

19 Drug orders **9094** are created each with its own unique drug order ID. Various
20 information is collected as part of the drug order including the type of drug, the dosage, start
21 date, frequency, stop date, to name but a few elements typical of a drug order. The drug order
22 information **9094** is associated with the unique medical order ID **9092** assigned to that particular

1 patient. All of the medical order information is associated with patient visit information 9017
2 which allows that information to be uniquely identified with a particular patient for a particular
3 visit.

4 Referring again to Figure 4B, the system is also capable of annotating and storing various
5 log items 9080. For example, an event log item is given a number, a patient profile item has its
6 own number, as do neurological, cardiographic, pulmonary, renal, and other events can have log
7 items associated with them and may be used as input to any of the note taking of the present
8 invention.

9 Referring to Figure 6 and 6A, the logical data structure of the patient care functionality of
10 the present invention is illustrated. Each patient visit with its unique ID 9017 has a number of
11 other pieces of information associated with it. For example, physician-patient tasks are tracked
12 9098 and have a unique task ID associated with them. The patient code status 9096 is
13 documented and associated with the physician-patient task 9098 task ID. This information is
14 uniquely associated with the patient visit via the the patient visit ID 9017.

15 Laboratory information 9100 has a unique lab ID associated with it. That information is
16 keyed to the visit ID and records the specimen taken, the date it was taken, and various other
17 information germane to the laboratory procedure involved. Other lab procedures 9102 are also
18 documented with another unique ID. "Other" lab ID is associated with the laboratory ID 9100
19 which again is uniquely associated with the particular patient.

20 Microbiological studies 9104 are documented together with the date and the date taken
21 and the type of study involved. Any study of microorganisms 9106 is documented with a unique
22 microorganism ID. Micro sensitivities 9108 which record the sensitivity to microorganisms and

certain antibiotics is recorded and associated with the microorganism ID **9106**. This information in turn is associated with a microbiological study **9104**, all of which is associated with the unique patient visit ID **9107**.

Respiratory studies **9101** are also recorded with unique identification numbers and a description. This information is again associated with the patient visit ID **9107**.

Referring now to Figure 6A, the logical data structure of the patient care functionality of the Present Invention is further illustrated. Other organism studies **9118** are also conducted to determine any other conditions associated with microorganisms that might exist with the particular patient. This other organism information **9118** is associated with the microorganism studies **9106** which in turn is associated with the microbiology category of information of the present invention **9104**.

Various diagnostic imaging also takes place and is recorded. This image information **9114** has unique image ID associated with each image and comprises associated information such as the image type, the date performed, and other information relevant to the diagnostic imagery. The result of the image taken **9116** is also uniquely identified with the image ID and a unique image result ID. This information is associated with the image information **9114** which again is uniquely associated with the patient visit ID.

Various intake and output for the patient's biological functioning is recorded **9110**. Intake and output total **9112** is recorded and uniquely associated with the intake/output identification note **9110**. Intake/output totals **9112** also comprised the weight the total taken in, the total out, and five-day cumulative totals for biological functioning of the particular patient.

Referring to Figure 7, The Logical Data Structure Concern with Reference Information

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1 for the present invention is illustrated. This data structure allows only certain ranges of data to
2 be input by care givers into the system. This is accomplished by having categories of
3 information **9120** each category capable of having only certain values. Similarly, each type of
4 data **9126** associated with each category is only permitted to have certain values. This
5 combination of Category and Type results in a Combined ID **9122** which can be used in
6 combination with certain values **9128** to create a value and combination **9124** that can be
7 presented to a care giver viewing and entering data. This effectively limits errors in data entry
8 by only allowing certain values to be entered for given types of data. For example, if only
9 milligrams of a medication are supposed to be administered, this data structure prevents a care
10 giver from administering kilograms of material since it is not a permitted range of data entry.
11 The “nextkey” function **9027** is the function that keeps track of the ID’s that are given during the
12 administration of the present invention. This function insures that only unique ID’s are given
13 and that no identical ID’s are given to two different patient’s for example.

14 Referring to Figure 8, the Logical Data Structure of the Vital Signs Functionality of the
15 Present Invention is illustrated. Vital sign header information **9120** is created and uniquely
16 associated with the visit ID for the particular patient. This header information comprises a date-
17 time stamp combined with hospital information, medical reference numbers, and identification of
18 the patient. Vital sign details **9122** are also created and uniquely date-time stamped and
19 associated with the particular visit ID for the patient. This information comprises all manner of
20 vital sign information relating to blood pressure, respiration, and other factors. Vital sign
21 information is associated with the patient visit **9017** and the demographic information concerning
22 the patient **9016**. Such associations of information can be the basis for later studies.

Referring to Figure 8A, Additional Vital Sign Logical Data Structures are illustrated. For example, a vital sign log header **9120** is created using the unique hospital ID and medical record numbers. Other information such a patient name, and date-time stamp are also stored. Vital sign log details **9124** are created and associated with the vital sign log header **9120**. For example, blood pressure measurements, respiration, and other factors are all detailed for a particular hospital ID. It should be noted that all vital sign data is logged in and kept by the systems of the present invention. Where vital sign information is received but cannot be associated with a particular patient, such communications are noted as errors.

Vital sign error details **9126** are also recorded and associated with a particular hospital. Information and the vital sign error detail also comprises heart rate, blood pressure, and other information. This information is associated with a vital sign error header **9130** which is associated with the hospital identifier and the patient first and last name and other information. Various vital sign error codes **9128** exist with the present invention and are used in association with the vital sign error detail **9126**. This information however relates to communications of vital sign data that are deemed "errors" as noted above.

Care Net patient location **9132** is recorded and associated with a particular hospital ID and location ID for the particular patient. Carenet is a proprietary product designation of Hewlett-Packard and is kept by the system of the present invention since it identifies the equipment from which measurements come. The ICU bed information **9038** is associated with the Care Net patient location **9132**.

Referring to **Figure 9**, the distributed architecture of the present invention is shown. In concept, the distributed architecture comprises a headquarters component **200**, a

1 command center/remote location **202**, and a hospital ICU **204**, which, while represented as a
2 single hospital in this illustration, in the preferred embodiment comprises several hospital ICUs
3 at different locations. The headquarters unit **200** comprises a database server and data
4 warehouse functionality, together with a patient information front end. The patient information
5 front end **206** provides patient specific information to the command center/remote location. The
6 database server/warehouse function **208** comprises the amassed information of a wide variety of
7 patients, in their various conditions, treatments, outcomes, and other information of a statistical
8 nature that will assist clinicians and intensivists in treating patients in the ICU. The headquarters'
9 function also serves to allow centralized creation of decision support algorithms and a wide
10 variety of other treatment information that can be centrally managed and thereby standardized
11 across a variety of command center/remote locations. Further, the database server/data
12 warehousing functionality **208** serves to store information coming from command center/remote
13 locations replicating that data so that, in the event of a catastrophic loss of information at the
14 command center/remote location, the information can be duplicated at the command
15 center/remote location once all systems are up and running.

16 At the hospital ICU **204**, each patient room **232**, **234** has a series of bedside monitors and
17 both video and audio monitoring of each patient in the patient room. Each ICU further has a
18 nurse's station with a video camera and monitor **230** so that videoconferencing can go on
19 between the nurses and doctors at the nursing station and those intensivists at the command
20 center/remote location. The monitoring equipment at the ICU is served by a monitor server **236**,
21 which receives and coordinates the transmission of all bedside monitoring and nurses station
22 communication with the command center/remote location. Finally, each ICU has a patient

1 information front end **228**, which receives and transmits to the command center/remote location
2 information concerning the identity and other characteristics of the patient.

3 Command center/remote location **202** comprises its own video capture and monitoring
4 capability **212** in order to allow the intensivists to view the patients and information from the
5 bedside monitoring as well as to have videoconferencing with the nursing station and with
6 patients as the need arises. Information from the monitor server **236** at the hospital ICU is served
7 to an HL7 (the language for transmitting hospital/patient/diagnostic data) gateway **214** to a
8 database server **222**. In this fashion, information from the bedside monitors can be stored for
9 current and historical analysis. Monitor front ends **216** and **218** allow technicians and command
10 center/remote location personnel to monitor the incoming data from the patient rooms in the
11 ICU. Information from the patient information front end **228** is provided to an application server
12 **224**, having its own patient information front end **226** for aggregating and assembling
13 information in the database **222** that is associated with individual patients in the ICU.

14 It is expected that there will be a great deal of concurrent hospital data that is necessary to
15 the implementation of the present invention. It is therefore expected that there will be a legacy
16 database system **210** having a front end **220** from which intensivists and command center/remote
17 location personnel can retrieve legacy database information.

18 Referring to **Figure 10**, a system architecture of one embodiment of the present invention
19 is illustrated. Headquarters **200** comprises an application server **238**, an NT file server **240**, and
20 Sun SPARC Enterprise 250 **242** and Enterprise network management system **244**, a Cisco 3600
21 router **246**, a Cisco 2924 switch **248**, and a hot phone **250**. The application server **238** is
22 designed to monitor and update those applications used at the command center/remote location.

The NT file server serves to monitor, store, and replicate information coming from the command center/remote locations. The SPARC Enterprise 250 server **242** is a disc storage server, for storing and serving information, such as practice guidelines, algorithms, patient information, and all matter of other information records that must be stored in order to support the present invention. As explained below, the SPARC Enterprise 250 server and other components are such as routers and switches are commonly used in the ICU, the command center/remote location, and the headquarters. For example:

The Cisco 3600 router is a multi-function device that combines dial access, routing, and local area network (LAN) to LAN services, as well as the multi-service integration of voice, video, and data in the same device. This is necessary, since the various command center/remote locations, headquarters, and intensive care units all must integrate and transmit video, audio, and data among the various entities.

The Cisco 7204 is a router which provides high speed LAN interconnect, virtual private networks, and Internet access, all of which is required for providing the communication in the network of the present invention; and

The Cisco 2924 switch is an autosensing fast ethernet switch, allowing networked multimedia and virtual LAN support. Multi-level security is also offered in the switch to prevent unauthorized users from gaining access and altering switch configuration. These components are also identified in the figures (below).

The particular commercial systems named here are given as but some examples of equipment available today. The function of these equipment is the important factor. Other similar or improved equipment can also be utilized.

1 The network management system **244** allows the entire traffic and condition of the
2 network to be monitored and to allow maintenance to take place. The router **246** and switch **248**
3 is used for communication with the various command center/remote locations that are served by
4 the Headquarters component. The Headquarters component interacts via frame relay with the
5 command center/remote location **202**.

6 Command center/remote location **202** comprises an applications server **262** for the
7 purpose of running various applications for the intensivists and command center/remote location
8 staff. The NT file server **264** at the command center/remote location allows patient files,
9 historical files, algorithms, practice standards, and guidelines, to be served to the clinicians and
10 intensivists to assist in monitoring the patients. The Sun SPARC Enterprise 250 **266** is used to
11 for storage purposes as noted above. The Enterprise network management system **268** monitors
12 the overall health of the network of command center/remote locations and intensive care units as
13 well as the functionality of the individual pieces of equipment within the command
14 center/remote location. A Cisco 2924 switch **256** and Cisco 7204 router **258**, combined with the
15 Cisco 3600 router **260** allows for point to point communication over a T1 line, with a plurality of
16 intensive care units located remotely from the command center/remote location. Hot phones **252**
17 and **254** allow communication with the headquarters and the intensive care unit.

18 Intensive care unit **204** comprises a Cisco 2924 switch **272** for the purpose of interfacing
19 with the various audio-video feeds **274**, **276** from the various patient rooms and the nursing
20 station. A local work station **280** is connected to a scanner **282** which allows data to be input,
21 scanned, and communicated via the point to point T1 communications to the command
22 center/remote location. Further, the workstation **280** provides for textual advice and patient

1 orders to be delivered to the intensive care unit for execution. The intensive care unit also
2 comprises a laser printer **284** for the printing of patient orders and other information relevant to
3 the care of intensive care patients.

4 Referring to **Figure 11**, the videoconferencing/surveillance/imaging components of the
5 present invention are illustrated. The hospital ICU **204** comprises a series of video cameras **290**,
6 which are located in patient rooms and at the nurse's station. Control for the cameras is provided
7 through an RS424 to RS232 converter **288**, with instructions for imaging emanating from the
8 workstation at the command center/remote location **252** through the ICU workstation **280**
9 through a multi-port serial controller **286**. Video feed from the video cameras **290** is provided to
10 an audio-video switcher **292**, which in turn provides its output to the multi-port serial controller
11 **286** for subsequent viewing at the nurse's station and at the command center/remote location. Of
12 equal importance is a microphone feed from the patient and from the nurses. That microphone
13 **296** provides its signal to an audio line amplifier **294**, which in turn provides an audio feed to the
14 audio-video switcher **292**. In this way, a patient can provide information, as can nurses who are
15 visiting the patient during the course of patient care. It is also important that information of an
16 audio nature be fed to the intensive care unit, both to the patient rooms and to the nurse's station.
17 To do this, the multi-port serial controller **286** provides an audio signal to a reverse audio
18 switcher **298**, which in turn provides information to speakers **300** that are located at the nurse's
19 station as well as at the bedside of the patients. Information to the reverse audio switcher is
20 provided an audio amplifier **302** from information from a video codec **304**, which in turn is
21 connected to the workstation at the ICU. As noted earlier, a scanner **282** is provided, so that

1 information can be scanned and provided to the command center/remote location **202** and a hot
2 telephone **278** communicates with a telephone **252** at the command center/remote location.

3 Referring to **Figure 12** the vital signs data flow is illustrated. The monitoring system at
4 each ICU bedside comprises a monitoring system for monitoring the vital signs for the patient.
5 The vital sign monitoring system **450** captures vital sign data **452** and transmits that vital sign
6 data **454** using the HL7 language (the standard processing language for hospital data and
7 information). The processor at the ICU processes the vital sign data for transmission and storage
8 purposes and transmits that information to the remote location. Vital sign data is then loaded
9 into the data base **458**. The data base for each individual patient is then reviewed and process
10 rules are applied **460** to the vital sign data. These process rules relate to certain alarming
11 conditions which, if a certain threshold is reached, provides an alarm to the intensivist on duty.
12 The vital sign alarm **462** is then displaced to the intensivist who can then take appropriate action.
13 A typical type of rule processing of the vital sign data might be if blood pressure remains at a
14 certain low level for an extended period of time, or if heart rate remains high for an extended
15 period of time. In addition a wide range of other rules are provided which will provide an
16 audible alarm to the intensivist before a critical situation is reached.

17 In addition to the information being provided to the alarming system for the intensivist,
18 the vital sign data **464** is also transmitted **466** into a database warehouse **468** comprising vital
19 sign data **470** from not only the individual patient but from all of the patients being cared for in
20 the ICU. This database warehouse provides the ability to do data mining for trends that can give
21 rise to additional process rules and vital sign thresholding. In addition to the transmission of
22 vital sign data **454** to the remote site, the vital sign data is displayed in real time at the ICU **472**.

Referring to **Figure 13(a)** the diagnostic imaging interaction is illustrated. X-rays for example, are created and transmitted to the command center **472**. Additionally, the information could be ACT scan, MRI, or any other method of medical diagnostic imaging. The x-ray image is captured at the command center **474** where it is stored and in addition displayed on the image monitor **476** for the intensivist to review.

Referring to **Figure 13(b)** the interactive video session is illustrated. A video conferencing session is established **478** regarding a particular patient in an ICU bed. Using the video cameras in each room and/or at the nurses station at the ICU, the patient and/or the nurse can be viewed **480**. On the other end of the video conferencing session is the intensivist who can then both visually and orally communicate with the patient and/or nurse **482**.

Referring to **Figure 14** the physician resources and order writing data interface is illustrated. The user interface **484** allows the physicians to access physician resources **486**. These resources provide guideline for the treatment of the critically ill. In this example the intensivist is requested to enter the antibiotic associated with colitis **488**. The system then generates a request for a fecal leukocyte test **490**. This request is translated into an order writing module **496** which results in the actual order for the test **502**. Since the order needs to be transmitted to the appropriate organization for execution, an appropriate order is generated to the microbiology laboratory **500** in this instance. The order results are then achieved **506** and the completion of the order is reported to the order writing assignment manager **496**. In addition, the order writing module **502** also results in a task list **504** of orders for various other individuals in laboratories. In addition, user interface **484** allows the physician to re-enter the physician resources module at any particular location with results of the tests. These tests are then fed into

- 1 the system to continue with the diagnostic algorithm processing of the patient test results 494.
- 2 The user interface also allows interaction with the resident data base 498

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Referring to **Figure 15** the physician resources database data interface is illustrated.

User interface **508** allows the intensivist to interact with the physician resources data base **510**.

In this example, resident data base **524** which comprises the identification and background of the resident admitting the patient causes an admission diagnosis **526** to be created. In this

example a diagnosis of pancreatitis is illustrated. This diagnosis of pancreatitis **522** alerts the

physician resources module **510** which causes an entry for the topic pancreatitis **512**. The

diagnosis algorithm for pancreatitis **514** is then retrieved and a request for an Apache II score

516 is requested. The system also requests information for operative data **528** describing what

if any operations have taken place with respect to this patient, vital sign data **530**, request for

laboratory information **532**, past medical history for the patient **534** and patient demographics

536. All this information is provided to the Apache II score assignment manager **538** which

assigns an Apache II score based upon weighted composite up to twenty five different

variables. This Apache II score is provided to the Apache II score request module **516**. If the

severity based Apache II score is greater than or equal to eight the diagnostic of the system

continue **520**. If the Apache II score is less than eight, the patient is triaged to a none ICU bed

518 since the patient will not necessarily require intensive care thereby saving relatively scarce

resources of the ICU for those who are truly critically ill.

Referring to **Figure 16** the automated coding/billing work flow and data flow is illustrated.

Clearly ICUs must be paid for the care that they give. At the outset of the visit **540** the user

interface **542** allows for the input of ICD 9 diagnosis code information concerning complexity of

the case, whether the patient is stable, whether the physician involved is the attending physician

or consulting physician and all other manner of information required for billing purposes. In

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1 addition, resident data **544** is input such as patient demographics, insurance information,
2 physician, guarantor, the date that the service is provided. All this information is provided to the
3 data manager **546** which assembles the required data element for subsequent processing. The
4 data manager sends the demographic, physician, guarantor, insurance and related information to
5 a bill generator **548** which begins to assemble of the information to subsequently generate a bill.
6 Clinical information is provided to the CPT code assignment manager which assigns codes based
7 upon the scores and user input for bill generation purposes. A history of present illness (HPI)
8 score **560** is generated along with a review of systems (ROS) score **562**. A PFSH score **564** is
9 generated along with a score relating to the physical exam **566**. An MPM score **568** which is a
10 score relating to the severity of the illness is also generated. All of these various scores are
11 provided to the CPT assignment manager **558**. Periodically information is downloaded for
12 management reports **556**. Once all of the information for the CPT code assignment is generated
13 that information is provided to the bill generator **548** which assembles all the data elements
14 needed to generate an HCFA1500 claim form. The input for the bill generator is then verified
15 **550** where the physician can disagree with code assignments return progress notes and generally
16 review the bill. This smart processing of the HCFA1500 claim form allows for fewer mistakes
17 to be made. If there is any error or additional information that is required, the verification
18 process fails the proposed claim form and information regarding that failure is provided back to
19 the resident data for completion of any missing items. Once an invoice has been verified as
20 having the appropriate information to be submitted the HCFA1500 claim form is generated **554**.
21 Additional information is written to a billing data file **552** for importation to the patient
22 accounting system of the present invention.

Referring to **Figure 17** the order writing data flow is illustrated. Order entry user interface **600** allows the intensivist to order procedures and medication to assist the patients in the ICU. For example, the intensivist can order an ECG **604**. Thereafter the order is reviewed and a digital signature relating to the intensivist is supplied **606**. Once reviewed and signed off, the order is approved **607** and sent to the data output system **610**. Thereafter the data output system prints the order to the printer in the ICU **616**. For record keeping purposes the order is exported in the HL7 language to the hospital data system **618**. In addition the data output system adds an item to the data base that will subsequently cause an intensivist to check the ECG results. This notification to the task list is provided to the database **614**. In addition, as part of the database an orders file relating to the specific patient is also kept. The fact that and ECG has been ordered is entered in the orders file for that patient.

In a similar fashion using the order entry user interface **600** the intensivist can order medications **602** for a patient. The medication order then is provided to an order checking system **608**. The order checking system retrieves information from the database **614** relating to allergies of the patient and medication list which includes medications which are already being administered to the patient. This allows for the order checking system to check for drug interactions. Further laboratory data is extracted from the database **614** and the order checking system checks to insure that there will be no adverse impact of the recommended dosage upon the renal function of the patient. Once the order checking system **608** is completed, the order is okayed and provided to the order review and signature module **606**. In this module the digital signature of the intensivist is affixed to the order electronically and the order is approved **607**. Thereafter it is provided to the data output system **610** where again the orders are printed for ICU

1 and 616 and for the hospital data system. In this case, any medications that are ordered are then
2 provided to the medications list file in the database 614 so that the complete list of all
3 medications that are being administered to the ICU patient is current.

4 Referring to **Figure 18** the event log is illustrated. The database 620 contains all manner
5 of notes and data relating to the particular patient that is admitted to the ICU. For example,
6 admission notes 622 are taken upon admission of the patient and stored in the file that is specific
7 to that patient. Progress notes 624 are created during the patients stay within the ICU to note the
8 progress the patient is making giving the various treatments. Procedural notes 626 are also
9 created by the intensivist to note what procedures have taken place and what if any events have
10 occurred associated with those procedures. Laboratory data such as positive blood cultures are
11 also stored in the file 628 in the database 620. Further x-ray data 630 and abnormal CT Scan
12 results are stored in the database.

13 The result of these individual files are then provided to an event log manager 632. For
14 example, admission notes might contain operations performed. Progress notes 624 might relate
15 to the operations performed. This information is provided to the event log manager 632.
16 Admission information is also input to the event log manager as are a listing of the procedures
17 administered to the patient. To the extent there are positive blood cultures in the laboratory data
18 628 those are provided to the event log manager 632 as are abnormal CT scan results. All of this
19 information is made available through the user interface 634. Thus the event log presents in a
20 single location key clinical information from throughout a patients stay in the ICU. The event
21 log user interface provides caregivers with a snapshot view of all salient events since admission.
22 All relevant data on procedures and laboratory tests, etc. are presented chronologically.

1 Referring to **Figure 19** the smart alarms of the present invention are illustrated. The
2 smart alarm system constantly monitors physiologic data (collected once per minute from the
3 bedside monitors) and all other clinical information stored in the database (labs, medications,
4 etc). The periodicity of the collection of data is stated for illustrative purposes only. It is well
5 within the scope of the present invention to collect physiological data at more frequent time
6 intervals. Thus, monitor **636** provides information in HL7 form to the interface engine **638**. The
7 physiological data is then formatted by the interface engine for storage in the database **640** where
8 all patient information is maintained. The rules engine **642** searches for patterns of data
9 indicative of clinical deterioration.

10 One family of alarms looks for changes in vital signs over time, using pre-configured
11 thresholds. These thresholds are patient-specific and setting/disease-specific. For example,
12 patients with coronary artery disease can develop myocardial ischemia with relatively minor
13 increases in heart rate. Heart rate thresholds for patients with active ischemia (e.g. those with
14 unstable angina in a coronary care unit) are set to detect an absolute heart rate of 75 beats per
15 minute. In contrast, patients with known coronary artery disease in a surgical ICU have alarms
16 set to detect either an absolute heart rate of 95 beats per minute or a 20% increase in heart rate
17 over the baseline. For this alarm, current heart rate, calculated each minute based on the median
18 value over the preceding 5 minutes, is compared each minute to the baseline value (the median
19 value over the preceding 4 hours). Physiologic alarms can be based on multiple variables. For
20 example, one alarm looks for a simultaneous increase in heart rate of 25% and a decrease in
21 blood pressure of 20%, occurring over a time interval of 2 hours. For this alarm, thresholds were
22 initially selected based on the known association between changes in these two variables and

adverse clinical events. Actual patient data were then evaluated to determine the magnitude of change in each variable that yielded the best balance between sensitivity and specificity. This process was used to set the final thresholds for the rules engine.

Alarms also track additional clinical data in the patient database. One alarm tracks central venous pressure and urine output, because simultaneous decreases in these two variables can indicate that a patient is developing hypovolemia. Other rules follow laboratory data (e.g. looking for need to exclude active bleeding and possibly to administer blood).

The purpose of the rules engine is to facilitate detection of impending problems and to automate problem detection thereby allowing for intervention before a condition reaches a crisis state.

Referring to **Figure 20** the procedural note-line log is illustrated. This log allows clinicians to evaluate the likelihood that a given procedure might result in further complications. In this example presented in this Figure 20 a catheter removal is illustrated. When a new catheter is inserted in a patient **648** a procedural note is created on the procedure note creation user interface **646**. The note is reviewed and a digital signature is attached to the note to associate the note with a particular intensivist **654**. The procedure is then approved and is provided to the data output system **656**. The procedural note is then printed on the printer in the ICU **658** and is exported in HL7 language to the hospital data system **660**. In addition, this also triggers a billing event and the data output system provides appropriate output to the billing module **662** to generate an invoice line item. In addition, the note is stored in the emergency medical record associated with the patient in the database **664**. In addition, the line log is updated in the database **664** to show what procedure was administrated to a patient at what time.

1 If there is an existing catheter, that is displayed to the intensivist at the procedure note creation
2 user interface 646. This would show an existing catheter changed over a wire 650. That
3 information is provided to the line id module 652 which extracts information from the line log in
4 the database 664. This information results in a note being created and provided to the note
5 review and signature module 664. Thus the line log contains, for each patient, relevant
6 information about all in-dwelling catheters, including type and location of the catheter, insertion
7 date, the most recent date that the catheter was changed over a wire, and the date the catheter was
8 removed. This information helps clinicians evaluate the likelihood that a given catheter is
9 infected and guides its subsequent management of that procedure.

10 Evidence-based Guidelines, Algorithms, and Practice Standards

11 Decision Support Algorithms

12 In order to standardize treatment across ICUs at the highest possible level, decision
13 support algorithms are used in the present invention. These include textual material describing
14 the topic, scientific treatments and possible complications. This information is available in real
15 time to assist in all types of clinical decisions from diagnosis to treatment to triage.

16 All connections among components of the present invention are presently with a high
17 bandwidth T-1 line although this is not meant as a limitation. It is anticipated that other existing
18 and future high bandwidth communication capabilities, both wired and wireless, as well as
19 satellite communications will be suitable for the communications anticipated for the present
20 invention.

21 As noted earlier, a key objective of the present invention is to standardize care and
22 treatment across ICUs. This is effective in the present invention by providing decision support to

1 intensivists as well as information concerning the latest care and practice standards for any given
2 condition. As noted in Table 1 below, a wide variety of conditions is noted. Each of the
3 conditions has an associated guideline of practice standard that can be presented to the intensivist
4 who might be faced with that particular condition in a patient. These guidelines of practice
5 standards can be accessed at the command center/remote location or at the ICU to assist in the
6 treatment of the patient. Thus, the general categories of cardiovascular, endocrinology, general,
7 gastrointestinal, hematology, infectious diseases, neurology, pharmacology, pulmonary, renal,
8 surgery, toxicology, trauma all have guidelines and practice standards associated with them.

9 **Table 1**
10 **EVIDENCE-BASED GUIDELINES**
11 **ALGORITHMS & PRACTICE STANDARDS**

12 **DECISION SUPPORT**

13 **CARDIOVASCULAR**

14 BRADYARRHYTHMIAS
15 CARDIOGENIC SHOCK
16 CARDIO-PULMONARY RESUSCITATION GUIDELINES
17 CONGESTIVE HEART FAILURE
18 EMERGENCY CARDIAC PACING
19 FLUID RESUSCITATION
20 HYPERTENSIVE CRISIS
21 **IMPLANTABLE CARDIO-DEFIBRILLATORS**
22 INTRA-AORTIC BALLOON DEVICES
23 MAGNESIUM ADMINISTRATION IN PATIENTS
24 MANAGEMENT OF HYPOTENSION, INOTROPES
25 MYOCARDIAL INFARCTION
26 MI WITH LEFT BUNDLE BRANCH BLOCK
27 PA CATHETER GUIDELINES & TROUBLE-SHOOTING

PERMANENT PACEMAKERS & INDICATIONS
PULMONARY EMBOLISM DIAGNOSIS
PULMONARY EMBOLISM TREATMENT
SUPRA-VENTRICULAR TACHYARRHYTHMIAS
UNSTABLE ANGINA
VENOUS THROMBOEMBOLISM PROPHYLAXIS
VENOUS THROMBOSIS: DIAGNOSIS & TREATMENT
VENTRICULAR ARRHYTHMIAS

ENDOCRINOLOGY

ADRENAL INSUFFICIENCY
DIABETIC KETOACIDOSIS
HYPERCALCEMIA: DIAGNOSIS & TREATMENT
HYPERGLYCEMIA: INSULIN TREATMENT
STEROID REPLACEMENT STRATEGIES
THYROID DISEASE

GENERAL

DEALING WITH DIFFICULT PATIENTS AND FAMILIES
END OF LIFE DECISIONS
ETHICAL GUIDELINES
PRESSURE ULCERS
ORGAN PROCUREMENT GUIDELINES

GASTROINTESTINAL

ANTIBIOTIC ASSOCIATED COLITIS
HEPATIC ENCEPHALOPATHY
HEPATIC FAILURE
MANAGEMENT OF PATIENTS WITH ASCITES
NUTRITIONAL MANAGEMENT
ACUTE PANCREATITIS
UPPER GI BLEEDING: STRESS PROPHYLAXIS
UPPER GI BLEEDING: NON-VARICEAL
UPPER GI BLEEDING:VARICEAL

HEMATOLOGY

HEPARIN
HEPARIN-INDUCED THROMBOCYTOPENIA
THE BLEEDING PATIENT
THROMBOCYTOPENIA
THROMBOLYTIC THERAPY
TRANSFUSION GUIDELINES
USE OF HEMATOPOETIC GROWTH FACTORS
WARFARIN

INFECTIOUS DISEASES

ACALCULUS CHOLECYSTITIS
ANTIBIOGRAMS
BLOODSTREAM INFECTIONS
CANDIDURIA
CATHETER RELATED SEPTICEMIA
CATHETER REPLACEMENT STRATEGIES
ENDOCARDITIS PROPHYLAXIS
ENDOCARDITIS DIAGNOSIS AND TREATMENT
FEBRILE NEUTROPENIA
FUO
HIV+ PATIENT INFECTIONS
MENINGITIS
NECROTIZING SOFT TISSUE INFECTIONS
NON-INFECTIOUS CAUSES OF FEVER
OPHTHALMIC INFECTIONS
PNEUMONIA, COMMUNITY ACQUIRED
PNEUMONIA, HOSPITAL ACQUIRED
SEPTIC SHOCK
SINUSITIS
SIRS
TRANSPLANT INFECTION PROPHYLAXIS
TRANSPLANT-RELATED INFECTIONS

NEUROLOGY

AGITATION, ANXIETY, DEPRESSION & WITHDRAWAL

BRAIN DEATH
GUILLAIN-BARRE SYNDROME
INTRACEREBRAL HEMORRHAGE
MYASTHENIA GRAVIS
NEUROMUSCULAR COMPLICATIONS OF CRITICAL ILLNESS
NON-TRAUMATIC COMA
SEDATION
STATUS EPILEPTICUS
STROKE
SUB-ARACHNOID HEMORRHAGE

PHARMACOLOGY

AMINOGLYCOSIDE DOSING AND THERAPEUTIC MONITORING
AMPHOTERICIN-B TREATMENT GUIDELINES
ANALGESIA
ANTIBIOTIC CLASSIFICATION & COSTS
DRUG CHANGES WITH RENAL DYSFUNCTION
PENICILLIN ALLERGY
NEUROMUSCULAR BLOCKERS
VANCOMYCIN
THERAPEUTIC DRUG MONITORING

PULMONARY

ARDS: HEMODYNAMIC MANAGEMENT
ARDS: STEROID USE
ARDS: VENTILATOR STRATEGIES
ASTHMA
BRONCHODILATOR USE IN VENTILATOR PATIENTS
BRONCHOSCOPY & THORACENTESIS GUIDELINES
COPD EXACERBATION & TREATMENT
CXR (INDICATIONS)
NONINVASIVE MODES OF VENTILATION
ENDOTRACHEAL TUBES & TRACHEOTOMY
TREATMENT OF AIRWAY OBSTRUCTION
VENTILATOR WEANING PROTOCOL

RENAL

ACUTE RENAL FAILURE :DIAGNOSIS
ACUTE RENAL FAILURE :MANAGEMENT & TREATMENT
DIALYSIS
DIURETIC USE
HYPERKALEMIA: ETIOLOGY & TREATMENT
HYPERNATREMIA: ETIOLOGY & TREATMENT
HYPOKALEMIA: ETIOLOGY & TREATMENT
HYPONATREMIA: ETIOLOGY & TREATMENT
OLIGURIA

SURGERY

OBSTETRICAL COMPLICATIONS
DISSECTING AORTIC ANEURYSM
POST-OPERATIVE HYPERTENSION
POST-OPERATIVE MYOCARDIAL ISCHEMIA (NON-CARDIAC
ARRHYTHMIAS AFTER CARDIAC SURGERY
POST-OPERATIVE BLEEDING
POST-OPERATIVE MANAGEMENT OF ABDOMINAL
POST-OPERATIVE MANAGEMENT OF OPEN HEART
POST-OPERATIVE MANAGEMENT OF THORACOTOMY
POST-OPERATIVE POWER WEANING
POST-OPERATIVE MANAGEMENT OF CAROTID
WOUND HEALING STRATEGIES

TOXICOLOGY

ACETAMINOPHEN OVERDOSE
ANAPHYLAXIS
COCAINE TOXICITY
ALCOHOL WITHDRAWAL
HYPERTHERMIA
LATEX ALLERGY
UNKNOWN POISONING

TRAUMA

ABDOMINAL COMPARTMENT SYNDROME
BLUNT ABDOMINAL INJURY
BLUNT AORTIC INJURY
BLUNT CARDIAC INJURY
DVT PROPHYLAXIS
EXTREMITY COMPARTMENT SYNDROME
HEAD INJURY
HYPOTHERMIA
IDENTIFICATION OF CERVICAL CORD INJURY
SPINAL CORD INJURY
OPEN FRACTURES
PENETRATING ABDOMINAL INJURY
PENETRATING CHEST INJURY

Referring to **Figure 21**, the acalculous cholecystitis decision support algorithm of the present invention is illustrated. If an intensivist suspects that acalculous cholecystitis may be present, the intensivist may not be certain of all of the aspects that would be indicative of this particular condition. Therefore, the intensivist is lead through a decision support algorithm, which first causes the intensivist to determine if the patient is clinically infected, either febrile or leukocytosis **800**. If this criteria is not met, the intensivist is prompted that it is unlikely that the patient has acalculous cholecystitis **802**.

If the patient is clinically infected **800**, the intensivist is prompted to determine whether the patient has had a previous cholecystectomy **804**. If patient has had a previous cholecystectomy, the intensivist is prompted that it is very unlikely that the patient has acalculous cholecystitis **806**. Alternatively, if a patient has not had a previous cholecystectomy, the intensivist is prompted to determine whether the patient has any of seven (7) risk factors, specifically: 1) Prolonged intensive care unit (ICU) stay (defined as greater than six (6) days); 2) recent surgery (particularly aortic cross clamp procedures); 3) hypotension; 4) positive end-

1 expiratory pressure (PEEP) greater than ten (10) centimeters (cm); 5) transfusion greater than six
2 (6) units of blood; 6) inability to use the gastrointestinal (GI) tract for nutrition; or 7)
3 immunosuppression (AIDS, transplantation, or leukemia) **808**. If the patient has none of these
4 seven risk factors, the intensivist is prompted that the patient probably does not have acalculous
5 cholecystitis **810**.

6 If the patient has any of the seven risk factors **808**, the intensivist is prompted to
7 determine whether the patient has any of the following symptoms: right upper quadrant (RUQ)
8 tenderness; elevated alkalinephosphatase; elevated bilirubin; or elevated liver transaminases
9 **812**. If the patient has none of these four (4) symptoms **812**, the intensivist is prompted to
10 consider other more likely sources of infection (see fever of unknown origin or FUO) **814**. If the
11 infection remains undiagnosed following an alternative work-up, the intensivist is prompted to
12 re-enter the algorithm **814**.

13 If the patient has any of these four (4) symptoms **812**, the intensivist is prompted to
14 determine whether alternative intra-abdominal infectious sources are more likely **816**. If
15 alternative intra-abdominal infectious sources are not more likely, the intensivist is prompted to
16 determine whether the patient is sufficiently stable to go for a test **826**. If the patient is
17 sufficiently stable to go for a test, the intensivist is prompted to perform an mso4
18 Cholescintigraphy **836**. The normal AC is excluded **838**. If the test indicates an abnormality, the
19 intensivist is prompted to consider a cholecystectomy or percutaneous drainage **840**. If the
20 patient is not sufficiently stable to go for a test, the intensivist is prompted to perform a bedside
21 ultrasound **828**. If no other infectious etiologies are identified and no abnormalities of the gall-
22 bladder are noted but: a) the patient remains ill **830**, the intensivist is prompted to consider
23 empiric cholecystostomy **832**. If no other infectious etiologies are identified and no
24 abnormalities of the gall bladder are noted but: b) the patient is improving **830**, the intensivist is
25 prompted to continue to observe the patient **834**.

26 If alternative intra-abdominal infectious sources are more likely **816**, the intensivist is

1 prompted to determine whether the patient is sufficiently stable to go for a test **818**. If the patient
2 is sufficiently stable to go for a test **818**, the intensivist is prompted to perform an abdominal CT
3 scan **820**. If no other infectious etiologies are apparent and the test: a) demonstrates
4 abnormalities of the gall-bladder but not diagnostic; or b) no gall-bladder abnormalities are noted
5 **822**, the intensivist is prompted to maintain continued observation of the patient **824**.
6 Alternatively, if this criteria not met **822**, the intensivist is prompted to perform an mso4
7 cholescintigraphy **836**. Normal AC is excluded **838**. If the test is abnormal, the intensivist is
8 prompted to consider cholecystectomy or percutaneous drainage **840**. If the patient is not
9 sufficiently stable to go for a test, the intensivist is prompted to perform a bedside ultrasound
10 **828**. If no other infectious etiologies are identified and no abnormalities of the gall-bladder are
11 noted but: a) the patient remains ill **830**, the intensivist is prompted to consider empiric
12 cholecystostomy **832**. If no other infectious etiologies are identified and no abnormalities of the
13 gall bladder are noted but: b) the patient is improving **830**, the intensivist is prompted to continue
14 to observe the patient **834**.

15
16 Referring to **Figure 22**, the adrenal insufficiency decision support algorithm of the
17 present invention is illustrated. When an intensivist suspects an adrenal problem may be
18 presented in a patient, the intensivist may initiate the adrenal insufficiency decision support
19 algorithm which prompts questions concerning all aspects of the condition. First the intensivist
20 is prompted to determine whether the patient is either hypotensive and/or has been administered
21 pressors for forty-eight hours or longer **900**. If neither condition is met, the system advises the
22 intensivist that it is unlikely that an adrenal problem is present **902**.

23 If one or both conditions are met, the intensivist is asked whether an obvious cause for
24 hypotensive blood pressure or treatment with pressors are manifested, such as hypovolemia or
25 low blood volume, myocardial dysfunction, or spinal injury **904**. If at least one of these obvious

causes is present, the intensivist is alerted by the system that the underlying cause must first be treated 906. If treatment of a suspected underlying cause is reversed, yet the hypotension or pressor need persists, the intensivist is further directed to determine whether other adrenal problems have occurred in the patient's history 908, 910, 912

In order to examine prior treatment issues, the intensivist is first prompted by the system to determine if the patient has been treated with steroids in the previous six months for at least a two week period 908. Next, the intensivist is prompted to determine whether the patient has hyponatremia or hyperkalemia 910. The intensivist is also prompted to determine whether the patient has experienced anticoagulation or become coagulopathic prior to the hypotension or pressor treatment 912. According to the responses provided by the intensivist to the system queries or blocks 908, 910, and 912, the system calculates a treatment action 914 as follows: The array of possible responses to diagnosis questions 908, 910, and 912 are given a Decision Code as shown in Table 1: Adrenal Insufficiency Considerations, below.

Table 1: Adrenal Insufficiency Considerations

Question 1	Question 2	Question 3	Decision Code
908	910	912	
N	N	N	A
N	N	Y	A
N	Y	N	B
N	Y	Y	C
Y	Y	Y	C
Y	N	N	D
Y	Y	N	B

Y	N	Y	D
Y	Y	Y	C

2 The possible decision codes of Table 1 are as follows:

Decision Code	Treatment Action
A	Do cosyntropin stim test
B	Consider possible Adrenal Insufficiency. Give decadron 5 mg IV, so cosyntropin stim test and empirically treat with hydrocortisone 50 mg IV every 8 hours until stim test results return.
C	Consider possible Adrenal Insufficiency, secondary to adrenal hemorrhage. Give decadron 5 mg IV, so cosyntropin stim test and empirically treat with hydrocortisone 50 mg IV every 8 hours until stim test results return.
D	Do cosyntropin stim test, may empirically treat with hydrocortisone 25-50 mg IV every 8 hours until stim test results return

Besides specialized treatment actions listed in the decision codes above, the intensivist is directed to administer a cosyntropin stimulation test 914 in order to see how much cortisone the adrenal gland is producing.

After performing the cosyntropin stimulation test, the intensivist is prompted to enter the patient's level of cortisol before administering cosyntropin and thirty minutes afterwards 916.

9 The software analyzes the test results as follows:

10 The results in Table 2, shown below, are shown as having certain decision codes A through F.

11 **Table 2: Cosyntropin Stimulation Test Results**

basal (A) < 15	basal (B) 15-20	basal (C) > 25
stim (D) < 5	stim (E) 5-10	stim (F) > 10

1 Depending upon the outcome of the analysis of Table 2, one of the treatment actions, shown
2 below in Table 3, will be displayed 918.

3 **Table 3: Cosyntropin Test Result Treatment Actions**

10570

Decision Code	Treatment Action
A + D	<u>Adrenal insufficiency diagnosed - treat with hydrocortisone 50 mg IV every 8 hours and consider endocrine consult</u>
A + E B + D	Probable Adrenal insufficiency- treat with hydrocortisone 25-50 mg IV every 8 hours and taper as intercurrent illness improves
A + F B + E	Possible Adrenal insufficiency- consider treatment with hydrocortisone 25 mg IV every 8 hours and taper as intercurrent illness improves
A + F B + F C + E C + F	Adrenal insufficiency unlikely- would not treat

66374
4
5 Referring to **Figure 23**, the blunt cardiac injury decision support algorithm of the present
6 invention is illustrated. If an intensivist suspects that blunt cardiac injury may be present, the
7 intensivist may not be certain of all aspects that would be critical to or indicative of this
8 particular condition. Therefore, the intensivist is lead through a decision support algorithm,
9 which first causes the intensivist to determine whether any of seven (7) risk factors are present:
10 1) was thoracic impact greater than fifteen (15) mph; 2) was the steering wheel deformed; 3) was
11 there precordial ecchymosis, contusions, or abrasions; 4) was marked precordial tenderness
12 present; 5) was there a fractured sternum; 6) were bilateral rib/costal cartilage fractures present;
13 7) were thoracic spine fractures present 1000. If none of the 7 risk factors are present, the
14 intensivist is prompted that no further evaluation is necessary 1002. If any of the 7 risk factors
15 are present, the intensivist is prompted to obtain an electrocardiogram (ECG) and chest X-ray
16 (CXR) 1004.

1 Once the results of the ECG and CXR are obtained, the intensivist is prompted to
2 determine: whether the ECG results are abnormal, with abnormal being defined as anything
3 other than sinus rhythm, including ectopy and unexplained sinus tachycardia (greater than 100
4 beats/minute); and whether the CXR results are abnormal, with abnormal being defined as any
5 skeletal or pulmonary injury, especially cardiac enlargement **1006**. If either the ECG or CXR are
6 not abnormal, the intensivist is prompted that a monitored bed is unnecessary for the patient
7 **1008**. If either the ECG or CXR are abnormal, the intensivist is prompted to determine whether
8 there is any hemodynamic instability (hemodynamic instability being defined as the absence of
9 hypovolemia, spinal cord injury, or sepsis) that cannot be explained by hypovolemia, spinal cord
10 injury, or sepsis **1010**.

1 If this criteria is not met, the intensivist is prompted: that the patient should be in a
2 monitored bed; that the ECG should be repeated at 24 hours; that, at any time, if unexplained
3 hemodynamic instability is present, the intensivist should request a stat echo; and that, if blunt
4 thoracic aortic injury is also suspected, a transesophageal echocardiogram (TEE) is favored over
5 a transthoracic echocardiogram (TTE) **1012**. Once the results of these tests are obtained, the
6 intensivist is prompted further to determine whether ectopy, arrhythmia, or abnormality is
7 present on the ECG **1014**. If none of these criteria are met, the intensivist is prompted that
8 cardiac injury is excluded **1016**. If any of these criteria are met, the intensivist is prompted that
9 he should consider monitoring the patient for an additional 24 hours **1018**.

10 If the internist determines that there is any hemodynamic instability that cannot be
11 explained by hypovolemia, spinal cord injury, or sepsis **1010**, he is prompted: to perform a stat
12 echo; and, if blunt thoracic aortic injury is also suspected, that a transesophageal echocardiogram
13 (TEE) is favored over a transthoracic echocardiogram (TTE) **1020**. Once the results of the stat

1 echo are obtained, the intensivist is prompted to determine whether the echo is abnormal with
2 possible causes for the abnormality being: pericardial effusion (tamponade; hypokineses or
3 akinesis (wall motion); dilatation or reduced systolic function; acute valvular dysfunction; and/or
4 chamber rupture **1022**. If the stat echo is abnormal, the intensivist is prompted to treat as
5 indicated for the particular cause of the abnormality **1026**. If the stat echo is not abnormal, the
6 intensivist is prompted to continue to monitor the patient and repeat the ECG at 24 hours **1024**.

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1 Once the results of the ECG are obtained, the intensivist is prompted to determine
2 whether ectopy, arrhythmia, or abnormality are present on the ECG **1014**. If this criteria is not
3 met, the intensivist is prompted that cardiac injury is excluded **1016**. If this criteria is met, the
4 intensivist is prompted that he should consider monitoring the patient for an additional 24 hours
5 **1018**.

6 Referring to **Figure 24**, the candiduria decision support algorithm, which is yet another
7 decision support algorithm of the present invention is illustrated. In the candiduria decision
8 support algorithm, the intensivist is presented with the criteria for diagnosing candiduria, or
9 severe fungal infection. First, the intensivist determines whether the patient has any medical
10 conditions that render the patient prone to fungal infections, such as diabetes, GU anatomic
11 abnormality, renal transplant, or pyuria **1100**. If there are no such conditions, the intensivist is
12 next prompted by the system to look for dissemination or spreading of the fungal infection **1102**.
13 If the infection does not seem to have spread, the intensivist is prompted to change the patient's
14 catheter and test for pyuria after twenty four hours have passed **1104**.

15 The intensivist is prompted by the system to determine whether the patient can have P.O.
16 **1106**. If the patient can take P.O., the system next prompts the intensivist to determine whether
17 azoles, an organic compound for inhibiting fungal growth, have been administered in the past
18 three days to fight the infection **1108**. If azoles have been previously administered, the systemic
19 infection diagnosis is confirmed and the intensivist is referred to the systemic amphotericin
20 dosing algorithm **1110**. If azoles have not been previously administered, directions for the
21 proper treatment dosage of fluconazole (a type of azole) is provided to the intensivist along with
22 adjustments for the species of fungus found **1112**. Where the patient cannot take P.O., the

1 intensivist is again referred to the systemic amphotericin dosing algorithm 1114.

2 When the patient does have some condition prone to fungal infection, the intensivist is
3 prompted to determine what other signs of dissemination are exhibited in the patient 1116. The
4 intensivist is prompted to see if the patient can take P.O. If the patient cannot take P.O., the
5 intensivist is referred to the systemic amphotericin dosing algorithm 1120. If the patient can take
6 P.O., the intensivist is prompted to check whether azoles have been administered in the previous
7 three days 1122. If azoles have been administered, the systemic infection is confirmed and the
8 intensivist is referred to the systemic amphotericin dosing algorithm 1124. If no azoles have
9 been administered previously, the intensivist is given instructions for administering fluconazole
10 to treat the fungal infection 1126.

11 If there is no evidence of dissemination, the intensivist is still prompted to determine
12 whether the patient can take P.O. 1128. Where the patient cannot take P.O., directions are
13 provided to administer amphotericin bladder washing procedures 1130. If the patient cannot take
14 P.O., the intensivist is prompted to determine whether azoles have been administered in the
15 previous three days 1132. If azoles have been administered, the systemic infection is confirmed
16 and the intensivist is referred to the systemic amphotericin dosing algorithm 1134. If no azoles
17 have been administered previously, the intensivist is given instructions for administering
18 fluconazole to treat the fungal infection 1136.

19
20 Referring to **Figure 25**, the Cervical Spine Injury decision support algorithm of the
21 present invention is illustrated. If an intensivist suspects that a cervical spine injury may be
22 present, the intensivist may not be certain of all of the factors that would be indicative of this

1 particular condition. Therefore, the intensivist is lead through a decision support algorithm,
2 which first prompts the intensivist to determine if the patient is awake, alert, not intoxicated, and
3 has no mental status changes **1200**. If this criteria is met, the intensivist is prompted to
4 determine whether the patient has any neck pain **1202**. If the patient does not have any neck
5 pain, the intensivist is prompted to determine whether the patient has any other pain which would
6 distract from their neck pain **1204**. If this criteria is not met, the intensivist is prompted to
7 determine whether the patient has any neurologic deficits **1206**. If this criteria is not met, the
8 intensivist is prompted that a stable C-spine is present if the patient can flex, extend, move neck
9 left/right without pain and without neck tenderness to palpitation **1208**. The intensivist is
10 prompted further that he can remove the collar **1208**.

11 Alternatively, if the patient does have neck pain **1202**, the intensivist is prompted to order
12 3 x rays **1210** consisting of: 1) lateral view revealing the base of the occiput to the upper border
13 of the first thoracic vertebra; 2) anteroposterior view revealing spinous processes of the second
14 cervical through the first thoracic vertebra; and 3) an open mouth odontoid view revealing the
15 lateral masses of the first cervical vertebra and entire odontoid process **1210**. If the x rays are
16 normal the intensivist is prompted to consider extension then flexion lateral x rays; if normal he
17 is prompted that he can remove the collar; if abnormal, he is prompted to obtain a surgical
18 consult **1212**. If the x rays are abnormal, the intensivist is prompted to obtain a surgical consult
19 and order a CT scan **1214**. If the x rays are indeterminate, the intensivist is prompted to order a
20 CT scan **1216**.

1 Alternatively, if the patient has no other pain which would distract from their neck pain
2 **1204**, the intensivist is prompted to order 3 x rays (the same types of x rays described in **1210**
3 above with the same prompting based on normal, abnormal, or indeterminate x rays) **1218**.

4 If the patient does have neurologic deficits **1206**, the intensivist is prompted to determine
5 whether the neurologic deficit is referable to the cervical spine **1226**. If this criteria is not met,
6 the intensivist is prompted to order 3 x rays (the same types of x rays described in **1210** above
7 with the same prompting based on normal, abnormal, or indeterminate x rays) **1218**. If the
8 neurologic deficit is referable to the cervical spine **1226**, the intensivist is prompted that the
9 patient should obtain immediate spine trauma surgery consult and CT or MRI (if available) **1228**.

10
11 Alternatively, if the intensivist determines that the patient does not pass the criteria of
12 being awake, alert, not intoxicated and having no mental status changes **1200**, the intensivist is
13 prompted to determine whether the patient has severe head trauma **1232**. If this criteria is met,
14 the intensivist is prompted to order CT of the neck with head CT **1236**. If this criteria is not met,
15 the intensivist is prompted to determine whether the patient has any neurologic deficit referable
16 to the cervical spine **1234**. If the intensivist determines that the patient does have a neurologic
17 deficit referable to the cervical spine, the intensivist is prompted that the patient should obtain
18 immediate spine trauma surgery consult and CT or MRI (if available) **1228**. If the intensivist
19 determines that the patient does not have a neurologic deficit referable to the cervical spine **1234**,
20 he is prompted to order 3 x rays (the same types of x rays described in **1210** above with the same
21 prompting based on normal, abnormal, or indeterminate x rays) **1218**.

Referring to **Figure 26**, the Oliguria decision support algorithm of the present invention is illustrated. If an intensivist suspects that Oliguria may be present, the intensivist may not be certain of all of the aspects that would be indicative of this particular condition. Therefore, the intensivist is lead through a decision support algorithm, which first causes the intensivist to determine if the patient is oliguric, with the criteria being passage of less than 25 cc of urine in a period of 2 hours **1300**. If this criteria is met the intensivist is prompted to determine whether the patient is anuric (the criteria for which is passage of less than 10 cc of urine in a 2 hour period) in spite of fluid administration **1302**.

If this criteria is met, the intensivist is prompted to determine whether the urinary catheter is working by flushing the catheter **1304**. The intensivist is then prompted to determine whether the catheter is functioning **1306**. If the catheter is not functioning, the intensivist is prompted to replace or reposition the catheter **1308**. If the catheter is functioning, the intensivist is prompted to determine whether the patient has a history of: 1) renal stone disease; 2) abdominal, pelvic, or retroperitoneal cancer; or 3) recent pelvic or retroperitoneal surgery **1310**. If any of these criteria are met, the intensivist is prompted to perform the following actions: 1) do renal ultrasound emergently to rule out obstruction; 2) while waiting for ultrasound, administer fluid at the rate of 7-15 ml/kg of bodyweight; and 3) send urine for specific gravity determination **1312**. Based on the renal ultrasound test results, the intensivist is prompted to determine whether an obstruction is present **1314**. If an obstruction is determined to be present, the intensivist is prompted to consult a urologist immediately **1316**.

Alternatively, if the intensivist determines that the patient does not have a history of: 1) renal stone disease; 2) abdominal, pelvic, or retroperitoneal cancer; or 3) recent pelvic or

1 retroperitoneal surgery **1310**, the intensivist is prompted to determine whether: 1) the patient has
2 a history of heart failure or known ejection fraction of less than 30 percent; or 2) there are rales
3 on the physical exam **1318**.

4 Alternatively, if following the renal ultrasound test, the intensivist determines that there is
5 no obstruction the intensivist is prompted to determine whether: 1) the patient has a history of
6 heart failure or known ejection fraction of less than 30 percent; or 2) there are rales on the
7 physical exam **1318**.

8 If the intensivist determines that the patient is not anuric **1302**, then the intensivist is
9 prompted to determine whether: 1) the patient has a history of heart failure or known ejection
10 fraction of less than 30 percent; or 2) whether there are rales on the physical examination **1318**.
11 If this criteria is not met, the intensivist is prompted to administer fluids to the patient at the rate
12 of 10-20 ml/kg of bodyweight **1320** and send the patient's urine sample for a specific gravity test
13 **1322** as more fully described in **Figure 26A**.

14 Alternatively, if the patient does: 1) have a history of heart failure or known ejection
15 fraction less than 30 percent; or 2) there are rales on the physical exam **1318**, the intensivist is
16 prompted to determine whether there has been a chest x-ray (CXR) in the last 6 hours **1324**. If
17 this criteria is not met, the intensivist is prompted to determine whether there has been a change
18 in respiratory status **1326**. If there has been no change in the respiratory status, the intensivist is
19 prompted to administer 7-15 ml of fluids per kg of bodyweight **1328** and to send the patient's
20 urine sample for a specific gravity test.

21 Alternatively, if the intensivist determines that there has been a change in respiratory
22 status **1326**, the intensivist is prompted to: 1) do a chest x-ray; and 2) determine whether there is

evidence of edema or congestion **1334**. If there is evidence of edema or congestion **1334**, the intensivist is prompted to: 1) insert a PA catheter to measure wedge pressure and liver function to direct fluid replacement; and 2) send urine creatinine and sodium **1332**.

If the intensivist determines that there has been a CXR in the last 6 hours **1324**, the intensivist is prompted to determine whether there is evidence of edema or congestion **1330**. If there is no evidence of edema or congestion, the intensivist is prompted to administer 7-15 ml of fluids per kg of bodyweight **1328** and send the patient's urine for a specific gravity test **1322**.

Alternatively, if the intensivist determines there is evidence of edema or congestion **1330**, the intensivist is prompted to: 1) insert a PA catheter to measure wedge pressure and liver function to direct fluid replacement; and 2) send urine creatinine and sodium **1332**.

Referring now to **Figure 26A**, the oliguria algorithm description continues. Following the specific gravity test of the patient's urine, the intensivist is prompted to determine whether the results indicate the specific gravity is less than 1.018. If this criteria is met, the intensivist is prompted to: 1) send blood and urine immediately to test for blood urea nitrogen (BUN), creatinine, electrolytes, and Hgb, and spot urine for creatinine, sodium, and sediment; and 2) administer 5-10 ml of fluid per kg of bodyweight **1356**. Once the results of these tests are obtained, the intensivist is prompted to determine what is the Hgb **1338**.

If the Hgb has increased by more than 1.5 gm/dl compared to the previous hgb **1340**, the intensivist is prompted to: 1) administer fluids 5-10 ml/kg of bodyweight and follow the urine output closely **1342**. Following this, the intensivist is prompted to determine whether the labs confirm renal failure by use of the formula $FE_{Na} = \frac{\text{Urine Na} \times \text{Serum Creatinine}}{\text{Urine Creatinine} \times \text{Serum Na}} \times 100$ **1344**.

1 If the Hgb is within 1.5 gm/dl from the previous hgb or no comparison **1352**, the
2 intensivist is prompted to determine what is the mean blood pressure **1354**. If the mean blood
3 pressure is determined to be within 20 percent or higher than the baseline blood pressure **1356**,
4 the intensivist is prompted to determine whether the labs confirm renal failure **1344**. If the mean
5 blood pressure is determined to be greater than 20 percent below the baseline pressure **1358**, the
6 intensivist is prompted to give additional fluids and consider invasive hemodynamic monitoring
7 **1360**. Following this, the intensivist is prompted to determine whether the labs confirm renal
8 failure by use of the formula $FE_{Na} = \text{Urine Na} \times \text{Serum Creatinine} / \text{Urine Creatinine} \times \text{Serum Na} \times$
9 **100 1344**.

10 Alternatively if the Hgb has decreased by 1.5 gm/dl compared to the previous hgb **1362**,
11 the intensivist is prompted to: 1) transfuse PRBCs as needed; 2) look for source of bleeding and
12 check PT, aPTT, & platelet count **1364**. Following this, the intensivist is prompted to determine
13 what is the mean blood pressure **1354**. If the mean blood pressure is determined to be greater
14 than 20 percent below the baseline pressure **1358**, the intensivist is prompted to give additional
15 fluids and consider invasive hemodynamic monitoring **1360**. Following this, the intensivist is
16 prompted to determine whether the labs confirm renal failure by use of the formula $FE_{Na} = \text{Urine}$
17 $\text{Na} \times \text{Serum Creatinine} / \text{Urine Creatinine} \times \text{Serum Na} \times 100$ **1344**.

18 If the labs do not confirm renal failure, as indicated by $FE_{Na} \leq 1$ percent **1346**, the
19 intensivist is prompted to: 1) continue to administer fluids and follow urine output; and 2)
20 recheck creatinine in 6-12 hours **1348**.

21 Alternatively, if the labs do confirm renal failure, as indicated by $FE_{Na} > 1$ percent **1350**,
22 the intensivist is prompted to: 1) place central venous pressure (CVP); 2) Assure adequate

1 intravascular volume; 3) give trial of diuretics: 40 mg lasix IV, if no response in 1 hour, give
2 hydrodiuril 500 mg IV, wait 20-30 minutes then give 100 mg lasix, if persistent oliguria, restrict:
3 1) fluids; 2) potassium & phosphate; if diuresis ensues, restrict only potassium & phosphate; in
4 both situations, adjust all renally excreted medications; and 4) see acute renal failure **1350**.

5 Referring now to **Figure 26B**, the oliguria algorithm description continues.

6 Alternatively, following the specific gravity test of the patient's urine, the intensivist is prompted
7 to determine whether the results indicate the specific gravity is greater than or equal to 1.018
8 **1336**. If this criteria is not met **1364**, the intensivist is prompted to determine whether the urine
9 is dark or tea colored **1366**. If this criteria is met, the intensivist is prompted to: 1) check
10 creatinine phospho/kinase; and 2) force fluids to induce diuresis **1368**.

11 If the intensivist determines that the urine is not dark or tea colored, the intensivist is
12 prompted to: 1) administer 10-20 ml of fluids per kg of bodyweight; and 2) check hgb **1370**. The
13 intensivist is then prompted to determine what is the hgb **1372**.

14 If the hgb is determined to be greater than 1.5 gm/dl higher than the previous hgb **1374**,
15 the intensivist is directed to: 1) force fluids; and 2) continue to follow the urine output **1376**.

16 Alternatively, if the hgb is determined to be within 1.5 gm/dl of the last hgb or there is no
17 hgb for comparison **1378**, the intensivist is prompted to determine what is the mean blood
18 pressure **1380**. If the mean blood pressure is determined to be 20 percent or higher than the
19 baseline pressure **1382**, the intensivist is prompted to: 1) continue to administer fluids; 2) follow
20 urine output; and 3) check creatinine in 6-12 hours **1384**. If the mean blood pressure is
21 determined to be greater than 20 percent below the baseline pressure **1386**, the intensivist is

prompted to: 1) continue to push fluids; 2) consider invasive hemodynamic monitoring; and 3) if post-op abdominal trauma, consider abdominal compartment syndrome 1388.

If the hgb is determined to be greater than 1.5 gm/dl below the previous hgb 1390, the intensivist is prompted to: 1) transfuse blood as needed; 2) look for bleeding source; 3) check PT, aPPT & platelet count; 4) continue to push fluids; and 5) recheck hgb in 1-2 hours 1392.

Referring to **Figure 27**, the open fractures decision support algorithm of the present invention is illustrated. Open fractures are where bone, cartilage, or a tooth break and push through the skin surface. The intensivist is first prompted by the system to determine whether the patient has an open fracture 1500. If one has occurred, the intensivist must then determine whether the wound is contaminated with soil, or was inflicted in a barnyard 1502 in order to address higher risk of infection. If the wound is contaminated with soil, or was inflicted in a barnyard, the intensivist is prompted to administer a high dose of penicillin to the antibiotics prescribed 1504. The intensivist is also prompted to take several treatment steps 1506. These treatment steps include administering tetanus prophylaxis, such an antitoxin injection, monitoring staphylococcus aureus until twenty-four hours after surgery, caring for the wound within six hours, and where the injury is found to be more severe during surgery, the intensivist is prompted to administer aminoglycosides for seventy two hours.

If the wound is not contaminated with soil, or was inflicted in a barnyard, the intensivist is next prompted to determine the severity of the wound 1508. To do so, the intensivist must determine the length of the wound and corresponding soft tissue damage. If the wound is either less than one centimeter and clean or greater than a centimeter long without extensive soft tissue damage, the Intensivist is prompted to take several treatment steps 1506 as previously described.

1 Where the soft tissue damage is extensive or amputation has occurred, the intensivist is
2 prompted by the system to make further determinations **1510**, **1512**, **1514** about the wound
3 caused by the fracture. The intensivist is prompted to determine if enough soft tissue coverage is
4 remaining for the wound to close and heal **1510**, if any arterial repair is needed **1512**, and if
5 extensive soft tissue damage with periosteal injury, and bone exposure **1514**. If there is
6 adequate soft tissue coverage, the intensivist is advised that risk of infection is low and directed
7 to take treatment actions **1516**. If arterial damage requiring repair is present, the intensivist is
8 advised by the system that risk of infection is moderate to high and given treatment instructions
9 **1518**. Where there is soft tissue injury with periosteal stripping and bone exposure, the
10 intensivist is alerted by the system that risk of infection is high and given treatment instructions
11 **1520**. The treatment instructions in each case **1516**, **1518**, **1520** include administering tetanus
12 prophylaxis, such an antitoxin injection, caring for the wound within six hours, and performing:
13 monitoring for staphylococcus aureus, and administering aminoglycosides and high doses of
14 penicillin, all for seventy two hours before and after any operative procedures.

15 If the intensivist has determined that no exposed fracture has occurred, the system next
16 prompts the intensivist to determine whether there is any evidence of neuro-vascular damage
17 **1522**. If there is evidence of neuro-vascular damage, the intensivist is prompted to consult with a
18 neurosurgeon or vascular surgeon immediately **1524**. If the intensivist determines there is no
19 evidence of neuro-vascular damage to the patient, the system next prompts the intensivist to
20 determine whether the patient has compartment syndrome **1526**. If there is evidence of
21 compartment syndrome seen in the patient, the intensivist is prompted to consult orthopedics
22 right away **1528**. If there is no evidence of compartment syndrome seen in the patient, the

1 intensivist is still prompted to consult orthopedics, but without any prompt for time sensitivity
2 **1530.**

3 Referring to **Figure 28**, the Pancreatitis diagnostic algorithm of the present invention is
4 illustrated. To evaluate whether a patient has pancreatitis, the intensivist is first prompted to
5 examine whether severe epigastric abdominal pains and amylase levels three times greater than
6 normal are present in the patient **1600**. If neither or one of the conditions is present, the
7 intensivist is prompted to consider other causes of the abdominal pain, such as mesenteric
8 ischemia, a perforated ulcer, intestinal obstruction, biliary colic, or an ectopic pregnancy **1602**.

9 If severe epigastric abdominal pains and amylase levels three times greater than normal
10 are present, the intensivist is next prompted to provide the Ranson Criteria which is a criteria
11 associated with the severity of pancreatitis and the potential outcome or prognosis at that
12 particular level of severity, or Apache II score which is also a score associated with the severity
13 of the disease and the potential prognosis at a particular level of the patient **1604**. If the patient
14 has a Ranson Criteria less than three or an Apache II score of less than eight, the intensivist is
15 prompted by the system to consider removing the patient from the Intensive Care Unit **1606**.
16 However, if the patient has a Ranson Criteria greater than three or an Apache II score of greater
17 than eight, the intensivist is instructed to perform an abdominal ultrasound test within twenty-
18 four hours **1607**. If the results of the ultrasound test show a biliary obstruction, the intensivist is
19 instructed to consider performing an ERCP to find and remove any gallstones **1608**.

20 If the abdominal ultrasound results do not show any biliary obstruction, intensivist is next
21 prompted to perform more diagnostic tests **1610**. The intensivist is directed to perform a
22 Dynamic IV contrast and an abdominal Computerized Tomography (CT) scan. If the intensivist

1 does not suspect a surgical condition exists, such as a perforated ulcer, mesenteric infarction or
2 pancreatic infection, the tests may be performed after three days have passed. If the intensivist
3 does suspect a surgical condition exists, the tests should be performed within three days. In
4 either case, if the patient has creatinine levels greater than or equal to 2 milligrams per dl, the
5 intensivist should not perform the Dynamic IV contrast test.

6 Once the CT scan is performed, the intensivist is prompted to determine whether
7 necrotizing pancreatitis is present **1612**. The intensivist is next required to determine whether
8 the patient has improved since admission **1614**. If no improvement has been seen, the intensivist
9 is directed to perform percutaneous fluid aspiration and do a gram stain culture the collected
10 fluid **1616**. If the culture shows infection **1618**, the intensivist is directed to perform surgical
11 debridement of the pancreas **1620**. If the results of the culture are sterile **1622**, the intensivist is
12 directed to closely follow up on the patient's condition **1624** and watch for clinical deterioration
13 **1626**. If the patient does further deteriorate, the intensivist is then instructed to perform a
14 surgical debridement of the pancreas **1628**. If the patient does not deteriorate, the intensivist is
15 still prompted to closely follow the patient's condition **1630**.

16 Where the CT scan does not show signs of necrotizing pancreatitis **1612**, the intensivist is
17 prompted by the system to closely observe the patient **1632**. The intensivist is also prompted to
18 check whether clinical deterioration is occurring **1634**. If no deterioration is observed, the
19 intensivist continues to observe the patient's condition **1636**. If clinical deterioration is occurring
20 **1634**, the intensivist is directed to perform percutaneous fluid aspiration and do a gram stain
21 culture the collected fluid **1616**. If the culture shows infection **1618**, the intensivist is directed to
22 order surgical debridement of the pancreas **1620**. If the results of the culture are sterile **1622**, the

1 intensivist is directed to closely follow up on the patient's condition **1624** and watch for clinical
2 deterioration **1626**. If the patient does further deteriorate, the intensivist is then prompted to
3 order a surgical debridement of the pancreas **1628**. If the patient does not deteriorate, the
4 intensivist is still directed by the system to closely follow the patient's condition **1630**.

5 Referring to **Figure 29**, the penicillin allergy diagnosis algorithm of the present invention
6 is illustrated. In order to diagnose a penicillin allergy, the intensivist is first prompted to
7 determine whether the patient has a history suggestive of previous penicillin or cephalosporin
8 anaphylaxis **1700**. Various known reactions, including angioedema, flushing, pruritis, airway
9 obstruction, syncope, and hypertension, are displayed for the intensivist's review. If the patient
10 has previously had any of these reactions, the intensivist is prompted to determine whether the
11 patient has ever taken synthetic or partially synthetic antibiotics, such as ampicillin, amoxicillin,
12 duricef or kefzol, without any anaphylaxis symptoms **1702**. If the patient has taken synthetics
13 without reaction, the intensivist is advised by the system that penicillin or cephalosporin may be
14 administered **1716**. If the patient has reacted to synthetic or partially synthetic antibiotics, the
15 intensivist is next prompted to determine whether the patient needs penicillin or cephalosporin
16 specifically **1704**.

17 If the patient is not required to have penicillin or cephalosporin, the intensivist is
18 prompted to administer the synthetic antibiotics **1706**. If the patient does need penicillin or
19 cephalosporin, the intensivist is directed by the system to consider consulting with an allergist or
20 immunologist and perform skin tests for reactions **1708**. Next, the intensivist is prompted to
21 enter whether the skin test was positive **1710**. If the results are negative, the intensivist is further
22 directed by the system to administer penicillin or cephalosporin with caution, to consider

1 pretreatment with benadryl or prednisone to counter any reaction, and to closely monitor the
2 patient 1712. If the results of the skin test are positive, the intensivist is prompted by the system
3 to perform desensitization procedures 1714.

4 If the patient does not have a history suggestive of previous penicillin or cephalosporin
5 anaphylaxis 1700, the intensivist is prompted to determine whether the patient has previously
6 experienced skin-level reactions, such as exfoliative dermatitis, Stevens Johnson Syndrome, or
7 Toxic Epidermal Necrolysis, when given penicillin or cephalosporin 1718. If the patient has
8 previously experienced one of these reactions, the intensivist is directed by the system to
9 administer an alternative antibiotic 1720. If the patient has not experienced one of these
10 reactions, the intensivist is prompted to determine whether there is a history of any rash when
11 given penicillin or cephalosporin 1722. If the patient has not previously had a rash when given
12 penicillin or cephalosporin, the intensivist is advised that the patient will most likely be able to
13 take penicillin or cephalosporin 1724.

14 If the patient has previously experienced a rash when given penicillin or cephalosporin,
15 the intensivist is prompted to determine whether the rash presented when the patient was given
16 ampicillin or amoxycillin 1726. If the rash resulted from ampicillin or amoxycillin, the
17 intensivist is next prompted to determine whether the rash was urticarial 1728. If the rash was
18 not urticarial, the intensivist is advised by the system that the patient probably can take penicillin
19 or cephalosporin, but should be closely monitored 1730. If the rash was urticarial, the intensivist
20 is prompted to determine whether or not the patient needs penicillin or cephalosporin 1704.

21 If the patient is not required to have penicillin or cephalosporin, the intensivist is directed
22 by the system to administer the synthetic antibiotics 1706. If the patient does need penicillin or

1 cephalosporin, the intensivist is directed to consider consulting with an allergist or immunologist
2 and perform skin tests for reactions **1708**. Next, the intensivist is prompted to enter whether the
3 skin test was positive **1710**. If the results are negative, the intensivist is further directed to
4 administer penicillin or cephalosporin with caution, to consider pretreatment with benadryl or
5 prednisone to counter any reaction, and to closely monitor the patient **1712**. If the results of the
6 skin test are positive, the intensivist is directed to perform desensitization procedures **1714**.

7 Referring to **Figure 30**, the Post-Op Hypertension decision support algorithm of the
8 present invention is illustrated. If an intensivist determines that there may be a possibility of
9 post-op hypertension, the intensivist may not be certain of all aspects that would be involved in
10 this particular condition. Therefore, the intensivist is lead through a decision support algorithm
11 which prompts the intensivist to determine the appropriate care to be given.

12 Initially, the intensivist is prompted to determine whether the patient is hypertensive (BP
13 greater than 20 percent above mean baseline) **1800**. If this criteria is met, the intensivist is
14 prompted to determine whether the patient has any of the causes of reversible hypertension: 1)
15 hypercapnia; 2) bladder distension; 3) pain; 4) increased ICP; 5) drugs (pressors, cocaine,
16 ketamine and chronic MAO use with indirect acting vasopressors); 6) automatic hyperreflexia; or
17 7) volume overload **1802**. If any of these criteria are met, the intensivist is prompted to first treat
18 those specific etiologies and, if pressure remains high, re-enter algorithm **1804**.

19 Alternatively, if none of these criteria are met **1802**, the intensivist is prompted to
20 determine whether the patient is at risk of injury from post-op hypertension (i.e., vascular
21 surgery, coronary artery disease, neurosurgery, ocular surgery, etc.) **1806**. If this criteria is not
22 met **1806**, the intensivist is prompted to determine whether the BP is greater than 40 percent

1 above mean baseline **1808**. If this criteria is not met, the intensivist is prompted that the patient
2 may not need BP treatment **1810**.

3 If the BP is greater than 40 percent above the mean baseline **1808**, the intensivist is
4 prompted to determine whether the patient is in pain **1812**. If this criteria is met **1812**, the
5 intensivist is prompted to treat pain and continue **1814**. Following this prompt **1814**, the
6 intensivist is prompted next to determine whether the patient is actively bleeding or at significant
7 risk for post-op bleeding (i.e., "moist closure" or high drain output) **1816**. If this criteria is met
8 **1816**, the intensivist is prompted to use only short acting agents including emolol and
9 nitroprusside as needed until bleeding has abated **1818**.

10 Alternatively, if this criteria is not met **1816**, the intensivist is prompted to determine
11 whether the patient is tachycardic (absolute greater than 90 bpm or ((relative greater than 15
12 percent over baseline)) **1820**. If this criteria is met **1820**, the intensivist is prompted to go to
13 Decision Table C, which is programmed for the condition of a high heart rate. If this criteria is
14 not met **1820**, the intensivist is prompted to eliminate (NOT C) Table C and proceed to the next
15 decision point **1820**.

HR↑Table C

	CAD	Y	Y	Y	N	N	N
	RAD	N	Y	Y	N	Y	N
	↓EF	N	N	Y	N	Y	Y
Treatment	1 ST	L	E	L	L	A	E
	2 ND	E	L	A	N	N	A

- 1 The intensivist is prompted next to determine whether the patient is bradycardic (absolute
2 less than 60 bpm) **1822**. If this criteria is met, the intensivist is prompted to go to Decision Table
3 B, which is programmed for the condition of a low heart rate.

HR ↓ Table B

	CAD	Y	Y	Y	N	N	N
	RAD	N	Y	Y	N	Y	N
	↓EF	N	N	Y	N	Y	Y
Treatment	1 ST	N	N	A	N	A	A
	2 ND	S	S	S	H	H	H

- 4 If this criteria is not met, the intensivist is prompted to eliminate (NOT B) Table B and
5
6 proceed to the next decision point **1822**. [Note: If NOT C and NOT B, the intensivist is
7 prompted to go to Table A by default, i.e., If NOT C and NOT B Then A].

HR (nl) Table A

	CAD	Y	Y	Y	N	N	N
	RAD	N	Y	Y	N	Y	N
	↓EF	N	N	Y	N	Y	Y
Treatment	1 ST	L	E	A	N	A	A
	2 ND	N	N	E	A	N	N

- 8
9 The intensivist is prompted next to determine, sequentially, table input values for CAD,
10 RAD, and EF.

- 11 In these decision tables, the letter references have the following meanings: L=labetalol,
12 E=esmolol, A=enalapril, N=nicardipine, H=hydralazine, S=nitroprusside. The reference to 1st

1 and 2nd means that treatment should begin with the 1st drug and add or substitute the 2nd drug as
2 needed.

3 Using the above decision tables, the intensivist is prompted to determine whether the
4 patient has known coronary artery disease (CAD) or 3 or more risk factors for CAD **1824**. If this
5 criteria is met **1824**, the intensivist is prompted to enter a "Y" or "YES" for CAD into the table
6 selected above in **1820** and **1822**. If this criteria is not met, the intensivist is prompted to enter a
7 "N" or "NO" for CAD into the table selected above in **1820** and **1822**.

8 Next, the intensivist is prompted to determine whether the patient has known reactive
9 airway disease (RAD)**1826**. If this criteria is met **1826**, the intensivist is prompted to enter a "Y"
10 or "YES" for RAD into the table selected above in **1820** and **1822**. If this criteria is not met, the
11 intensivist is prompted to enter a "N" or "NO" for RAD into the table selected above in **1820** and
12 **1822**.

13 Next, the intensivist is prompted to determine whether the patient has known EF less than
14 30 percent or a history of systolic heart failure **1828**. If this criteria is met **1828**, the intensivist is
15 prompted to enter a "Y" or "YES" for EF into the table selected above in **1820** and **1822**. If this
16 criteria is not met **1828**, the intensivist is prompted to enter a "N" or "NO" for EF into the table
17 selected above in **1820** and **1822**.

18 Based on the table selected in **1820** and **1822** above, and the table inputs determined from
19 **1824**, **1826**, and **1828**, the intensivist is prompted with the proper medication to administer for
20 the 1st and 2nd treatment.

21 If the patient is not in pain **1812**, the intensivist is prompted to employ the procedures
22 described above in **1816**.

If the patient is at risk of injury from post-op hypertension **1806**, the intensivist is prompted to determine whether the blood pressure is greater than 40 percent above baseline **1830**. If this criteria is met **1830**, the intensivist is prompted to employ the procedures described above in **1812**.

Alternatively, if this criteria is not met **1830**, the intensivist is prompted to determine whether the patient is in pain **1836**. If this criteria is met **1836**, the intensivist is prompted to treat pain and reevaluate following analgesia and, if still hypertensive, to continue algorithm **1838**. Following this action **1838**, the intensivist is prompted to employ the procedures described above in **1816**. If the patient is not in pain **1836**, the intensivist is prompted to employ the procedures described above in **1816**.

If the patient is determined not to be hypertensive **1800**, the intensivist is prompted to determine whether the patient requires their BP controlled near baseline (i.e., neurosurgery, carotid surgery, thoracic aorta surgery) **1832**. If this criteria is not met **1832**, the intensivist is prompted that the patient probably does not need treatment **1834**.

Alternatively, if this criteria is met **1832**, the intensivist is prompted to employ the procedures described above in **1836**.

Referring to **Figure 31**, the pulmonary embolism diagnosis algorithm is illustrated. If a pulmonary embolism is suspected, the intensivist is first prompted to determine whether the patient is hemodynamically unstable **2900**. If the patient is hemodynamically unstable, the intensivist is directed by the system to consider performing an immediate transthoracic echocardiogram, pulmonary angiogram and treatment consistent with massive pulmonary embolism **2902**. If the patient is not hemodynamically unstable, the intensivist is prompted to

1 bronchitis, pericarditis, viral pleurisy, pneumonia, and esophageal spasm **2912**.

2 Referring to **Figure 31A**, the pulmonary embolism algorithm description continues. The
3 intensivist enters the answers to the assessment queries posed **2906, 2908, 2910, 2912** into the
4 system. If two or more responses to the patient condition query **2906** were answered yes and one
5 or more questions were answered yes from: Heart rate > 90 beats/min, Temp \geq 38.0, CXR free of
6 abnormalities, or Leg symptoms c/w DVT of the symptoms query **2910**, the intensivist is
7 informed that a typical pulmonary embolism is present **2914**. Next, the system compares this
8 response to the answer to the alternative diagnosis query **2912**. If an alternative diagnosis is at
9 least as likely as pulmonary embolism **2916**, the intensivist is also given a low probability **2918**
10 to moderate probability **2920** risk factor. If an alternative diagnosis is less likely than pulmonary
11 embolism **2922**, the intensivist is given a moderate **2924** to high **2926** probability risk factor.

12 If less than two yes answers resulted from the patient conditions **2906**, the intensivist is
13 advised by the system that an atypical pulmonary embolism may be present **2928**. Next, the
14 system compares this response to the answer to the alternative diagnosis query **2912**. If an
15 alternative diagnosis is at least as likely as pulmonary embolism **2930**, the intensivist is told there
16 is no risk and low probability **2932** or some risk with a low probability **2934** risk factor. If an
17 alternative diagnosis is less likely than pulmonary embolism **2934**, the intensivist is given a no
18 risk and low probability **2938** to risk but moderate probability **2940**.

19 If at least one answer to the symptoms of syncope, blood pressure less than 90 mm Hg
20 with heart rate greater than 100 beats/min, receiving mechanical ventilation and/or oxygen
21 supplementation greater than 40%, and new onset or right heart failure **2910** is yes, the
22 intensivist is prompted with a message that severe pulmonary embolism is occurring **2942**. Next,

1 the system compares this response to the answer to the alternative diagnosis query **2912**. If an
2 alternative diagnosis is at least as likely as pulmonary embolism **2944**, the intensivist is told there
3 is a moderate probability of pulmonary embolism **2946**. If an alternative diagnosis is less likely
4 than pulmonary embolism **2948**, the intensivist is notified that a high probability of pulmonary
5 embolism is present **2950**.

6 Once the risk factors and probabilities are determined the system compares this
7 information to the VQ scan results. This comparison is performed according to the following
8 Table 4 below.

9 **Table 4: Probability table**

<u>V/Q Scan</u>	<u>Clinical Probability</u>		
	High	Moderate	Low
High	A	A	B
Intermediate	B	C	C
Low	B	C	E
Normal	E	E	E

15 Where the VQ scan column and the risk column intersect, a letter code is assigned to various
16 treatment instructions. The treatment instructions are as follows.

17 **A = Pulmonary embolus diagnosed. Begin treatment**

18
19 E = Pulmonary embolus excluded

20
21 B = Proceed with the following work-up:

- 22 1) Perform spiral CT(If patient has renal insufficiency [creatinine > 2.0], consider going directly
23 to pulmonary angiogram to reduce the potential dye load). If positive begin treatment,

- 1 2) If negative, assess for DVT using compression ultrasound or venography. If positive begin
2 treatment,
3 3) If negative, perform pulmonary angiogram. If positive begin treatment, if negative diagnosis
4 excluded.

5
6 C = Proceed with the following work-up:

- 7 1) Perform spiral CT. If positive begin treatment,
8 2) If negative, assess for DVT using compression ultrasound or venography. If positive begin
9 treatment,
10 3) If negative perform D-dimer assay(elisa only). If negative diagnosis excluded, If positive,
11 perform serial ultrasound of the lower extremities.

12
13 Once the correlation is made, the instructions associated with the letter code are displayed by the
14 system to prompt the intensivist with diagnosis and treatment instructions.

15 Referring to **Figure 32**, the seizure decision support algorithm of the present invention is
16 illustrated. If an intensivist encounters seizure in a patient, he may not be certain of all of the
17 aspects and the timelines that are critical to treating this particular condition. Therefore, the
18 intensivist is lead through a decision support algorithm, which divides the treatment sequence
19 into three segments: 0-30 minutes; 30-60 minutes; and beyond 60 minutes.

20 At the onset of a seizure, in the 0-30 minute segment of the algorithm, the intensivist is
21 prompted to give the patient lorazepam (0.1 mg/kg of bodyweight) in 2 mg boluses up to 8 mg
22 **2000**. Subsequently, the intensivist is prompted to give the patient phenytoin (18-20 mg/kg of
23 bodyweight) at 50mg/min of fosphenytoin (18-20 mg/kg of bodyweight) at 150 mg/min followed
24 by 5 mg/kg of bodyweight/day through separate IV line **2002**.

25 During the 30-60 minute segment of the algorithm, the intensivist is prompted to: reload
26 additional phenytoin or fosphenytoin (10 mg/kg of bodyweight) maintaining previous infusion;
27 and give additional lorazepam (0.05 mg/kg of bodyweight) **2004**. Subsequently, the intensivist is
28 prompted to begin continuous EEG monitoring **2006**.

1 The intensivist is then prompted to determine whether the patient is hemodynamically
2 stable **2008**. If hemodynamically stable, the intensivist is prompted to administer propofol 1-2
3 mg/kg of bodyweight bolus followed by 2-10 mg/kg/hr **2010**.

4 At the 60 minute segment of the algorithm, the intensivist is prompted that if seizure
5 activity stops, he should taper either midazolam or propofol over the next 12-24 hours while
6 maintaining phenytoin but if seizures persist, he is prompted to move to the pentobarbital coma
7 block **2012**.

8 Under pentobarbital coma, the intensivist is prompted to administer 10-15 mg/kg/hr and
9 to maintain until seizure control is achieved on EEG **2014**. The intensivist is prompted further
10 that the patient usually requires PA catheter and pressors to maintain hemodynamic control **2014**.

11 Alternatively, if the patient is determined to be hemodynamically unstable **2016**, the
12 intensivist is prompted to utilize fluids and pressors as needed (phynylephrine or dopamine)
13 midazolam 0.2 mg/kg bolus followed by 0.1-2.0 mg/kg/hr **2018**.

14 At the 60 minute segment of the algorithm, the intensivist is prompted that if seizure
15 activity stops, he should taper either midazolam or propofol over the next 12-24 hours while
16 maintain phenytoin but if seizures persist, he is prompted to move to the pentobarbital coma
17 block **2012**.

18 Under pentobarbital coma, the intensivist is prompted to administer 10-15 mg/kg/hr and
19 to maintain until seizure control is achieved on EEG **2014**. The intensivist is prompted further
20 that the patient usually requires PA catheter and pressors to maintain hemodynamic control **2014**.

1 Referring to **Figure 33**, the supra ventricular tachycardia (SVT) decision support
2 algorithm of the present invention is illustrated. If an intensivist determines that SVT is present,
3 the intensivist may not be certain of all aspects that would be involved in treating this particular
4 condition. Therefore, the intensivist is lead through a decision support algorithm which prompts
5 the intensivist to determine the appropriate care to be given.

6 Initially, the intensivist is prompted to determine whether SVT is stable or unstable **2100**.
7 If SVT is stable **2102**, the intensivist is prompted to determine whether the patient has a regular
8 or irregular rhythm **2102**. If the patient has a regular rhythm **2104**, the intensivist is prompted to
9 determine whether there is a wide complex or a narrow complex **2104**. If the intensivist
10 determines that there is a wide complex **2106**, the intensivist is prompted to administer adenosine
11 6 mg/12 mg (if needed) **2108**. Following the administering of adenosine **2108**, the intensivist is
12 prompted to consider that if the patient converts to sinus rhythm (SR) to – consider re-entrant
13 junctional or WPW re-entrant. If the wide complex recurs, treat the patient with esmolol or
14 Ca+2 blockers.

15 Alternatively; if no effect, the intensivist is prompted to consider V-tach **2112**. Next, the
16 intensivist is prompted to: 1) load procainamide 150 mg over 10 min, then 1 mg/min infusion;
17 and 2) synchronized cardiovert **2114**.

18 Alternatively, if the wide complex slows, the intensivist is prompted to consider SVT w/
19 aberrancy and continue to slow with esmolol or Ca+2 blockers **2116**.

20 The intensivist is prompted next to administer esmolol/calcium blockers and link to
21 ventricular rate control **2118**. The intensivist is prompted next to determine whether there has
22 been a conversion to SR **2120**. If there is no conversion to SR in 24 hours, the intensivist is

1 prompted to add antiarrhythmic agent and consider anticoagulation **2122**. The intensivist is
2 prompted next to determine whether there has been conversion to SR. If conversion to SR, the
3 intensivist is prompted to continue maintenance antiarrhythmic agent during hospitalization
4 **2124**. If no conversion to SR, the intensivist is prompted to cardiovert while on antiarrhythmic
5 & following heparinization **2126**.

6 If the patient has a regular rhythm **2104**, the intensivist is prompted to determine whether
7 there is a wide complex or a narrow complex **2104**. If the intensivist determines that there is a
8 narrow complex **2128**, the intensivist is prompted to to administer adenosine 6mg/12mg (if
9 needed) **2130**. If administering the adenosine **2130** slows the ventricular rate only and the atrial
10 rate persists, the intensivist is prompted to consider atrial flutter and continue to slow with
11 esmolol or Ca+2 blockers **2132**. The intensivist is prompted next to employ the procedures
12 described above in **2118**.

13 If administering the adenosine **2130** converts the patient to SR, the intensivist is
14 prompted to consider re-entrant sinus or junctional and if recurs, treat with esmolol or Ca+2
15 blockers **2134**.

16 If administering the adenosine **2130** slows both atrial and ventricular rates the intensivist
17 is prompted that there is a probable sinus tachycardia **2136**. The intensivist is prompted next to
18 continue to slow with esmolol **2138**. The intensivist is prompted next to employ the procedures
19 described above in **2118**.

20 If SVT is stable **2102**, the intensivist is also prompted to determine whether the patient
21 has a regular or irregular rhythm **2102**. If the patient has an irregular rhythm **2140**, the
22 intensivist is prompted that if no p waves, there is probable Atrial fibrillation **2142**. The

1 intensivist is prompted next to slow ventricular response with esmolol or Ca+2 blockers **2144**.

2 The intensivist is prompted next to employ the procedures described above in **2118**.

3 If the patient has an irregular rhythm **2140**, the intensivist is prompted to determine
4 whether there are more than 3 p wave types MAT – and to treat underlying lung dz. and avoid
5 theophylline compounds **2146**. The intensivist is prompted next to slow rate with Ca+2 blockers
6 only **2148**. The intensivist is prompted next to employ the procedures described above in **2118**.

7 Referring now to **Fig. 33A**, the description of the SVT decision algorithm continues. If
8 SVT is unstable **2101**, the intensivist is prompted to determine whether the patient has SBP less
9 than 80, ischemia, mental status changes **2150**. The intensivist is prompted next to perform
10 synchronous cardioversion (100 J, 200 J, 300 J) **2152**. The intensivist is prompted next that if
11 sinus rhythm: 1) correct reversible etiologies; 2) consider starting IV antiarrhythmic for
12 maintenance of sinus rhythm **2154**. Alternatively, following **2152**, the intensivist is prompted
13 next that if continued SVT: 1) correct reversible etiologies; 2) load IV antiarrhythmic (see dosing
14 guidelines) and repeat DC cardioversion **2156**.

15 For example, and without limitations, wide complex QRS Tachycardia is also addressed
16 in the decision support algorithm of the present invention. Referring to **Figure 34**, the wide
17 complex QRS tachycardia decision support algorithm is illustrated. If an intensivist determines
18 that there may be a possibility of wide complex QRS tachycardia, the intensivist may not be
19 certain of all aspects that would be involved in this particular condition. Therefore, the
20 intensivist is lead through a decision support algorithm which prompts the intensivist to
21 determine the appropriate care to be given.

22 Initially, the intensivist is prompted to determine whether the patient is hemodynamically

1 stable (no angina, heart failure, or hypotension (systolic less than 80 mm)) **2200**. If this criteria
2 is not met, the intensivist is prompted to go to the cardio-pulmonary guidelines algorithm which
3 is generally known to those skilled in the art.

4 Alternatively, if this criteria is met, the intensivist is prompted to determine whether the
5 patient is within 7 days of a myocardial infarction or at risk for myocardial ischemia **2202**. If the
6 patient is not within 7 days of a myocardial infarction or at risk for myocardial ischemia **2202**,
7 the intensivist is prompted to determine whether the wide complex QRS rhythm is sustained
8 (greater than 30 seconds) **2234**. If this criteria is not met, the intensivist is prompted to
9 determined whether the QRS is monomorphic **2236**. If the QRS is monomorphic **2236**, the
10 intensivist is prompted to determine whether the patient has structural heart disease **2242**. If the
11 patient has structural heart disease **2242**, the intensivist is prompted to: 1) monitor closely; 2)
12 look for reversible etiologies; and 3) consider antiarrhythmic therapy **2244**. If the patient does
13 not have structural heart disease **2242**, the intensivist is prompted to: 1) monitor closely; 2) look
14 for reversible etiologies; and 3) if recurs and symptomatic may require further testing (prolonged
15 holter or EP study) **2246**.

16 If the QRS is not monomorphic **2236**, the intensivist is prompted to determine whether
17 the QT is prolonged **2238**. If this criteria is met, the intensivist is prompted to: 1) check K; 2)
18 give Mg; and 3) consider overdrive pacing **2240**. If the intensivist determines that the QT is not
19 prolonged, **2238**, the intensivist is prompted to employ the procedures described above in **2242**.

20 If the wide complex QRS rhythm is sustained **2234**, the intensivist is prompted to
21 determine whether the rhythm is polymorphic or irregular **2208**. If the rhythm is polymorphic or
22 irregular, the intensivist is prompted to consider atrial fibrillation with accessory pathway

1 conduction and load with procainamide and get a cardiology consultation **2210**. If the rhythm is
2 not polymorphic or irregular, the intensivist is prompted with the question of whether he wishes
3 to: 1) perform ECG diagnosis; or 2) administer adenosine diagnostically **2220**. If the intensivist
4 makes the determination to perform an ECG diagnosis **2220**, he is prompted to go to the ECG
5 diagnosis algorithm **2300**.

6 If the intensivist makes the determination to administer adenosine diagnostically **2220**, he
7 is prompted to go to the administer adenosine branch of the algorithm **2222**. If there is no effect,
8 the intensivist is prompted that there is probable VT and to determine whether the VT is
9 monomorphic **2224**. If the VT is monomorphic **2224**, the intensivist is prompted to load with
10 procainamide and perform synchronous cardioversion **2226**.

11 Alternatively, if the VT is not monomorphic **2224**, the intensivist is prompted to load
12 with lidocaine and perform immediate cardioversion **2228**.

13 If the ventricular response is slowed after administering adenosine **2222**, the intensivist is
14 prompted to consider SVT with aberrancy and treat with esmolol or Ca blockers **2230**.

15 If the ventricular response converts to sinus rhythm after administering adenosine **2222**,
16 the intensivist is prompted: to consider re-entrant mechanism with BBB or WPW; and, 1) if
17 WPW consult cardiology for possible ablation **2232**.

18 If the patient is within 7 days of a myocardial infarction or at risk for myocardial
19 ischemia **2202**, the intensivist is prompted to determine whether the wide complex is sustained
20 (30 seconds) **2204**. If the wide complex is not sustained **2204**, the intensivist is prompted to
21 determine whether the patient: 1) symptomatic; 2) tachycardia runs are frequent; or 3) the
22 tachycardia rates are rapid (greater than 180) **2212**. If this criteria is not met, the intensivist is

1 prompted to observe **2216**. Alternatively, if this criteria is met **2212**, the intensivist is prompted
2 to: 1) administer lidocaine 100-200 mg & 1-4 mg/min infusion; and 2) amiodarone **2214**.

3 If the wide complex is sustained **2204**, the intensivist is prompted to determine whether
4 the rate is greater than 140/min **2206**. If this criteria is not met **2206**, the intensivist is prompted:
5 to consider accelerated idioventricular, and that in some patients this can lead to hemodynamic
6 compromise; and that 1) he can perform overdrive pacing if needed **2218**.

7 Alternatively, if this criteria is met, the intensivist is prompted to follow the procedures in
8 **2208**.

9 If the intensivist makes the determination to perform ECG Diagnosis **2220**, he is
10 prompted to go to the ECG Diagnosis branch of the algorithm **2220**. Referring now to Figure
11 34A, in the ECG Diagnosis branch, the intensivist is prompted to determine whether the patient
12 has known pre-excitation syndrome **2300**. If this criteria is met, the intensivist is prompted to
13 determine whether the QRS complexes are predominantly negative in leads V4-V6 **2302**. If the
14 QRS complexes are predominantly negative in leads V4-V6, the intensivist is prompted that
15 there is probable VT **2304**.

16 If the QRS complexes are not predominantly negative in leads V4-V6 **2302**, the
17 intensivist is prompted to determine whether there is a QR complex in one or more of leads V2-
18 V6 **2306**. If this criteria is met, the intensivist is prompted that there is probable VT **2308**.

19 Alternatively, if this criteria is not met **2306**, the intensivist is prompted to determine
20 whether there are more QRS complexes than P waves **2310**. If there are more QRS complexes
21 than P waves **2310**, the intensivist is prompted that there is probable VT **2312**. If there are not
22 more QRS complexes than P waves **2310**, the intensivist is prompted: to consider pre-excited

SVT; and that he may wish to perform EP study **2314**.

If the intensivist determines that the patient does not have known pre-excitation syndrome **2300**, the intensivist is prompted to determine whether there is an RS complex present in any precordial lead **2316**. If this criteria is not met **2316**, the intensivist is prompted that there is probable VT **2318**.

Alternatively, if this criteria is met **2316**, the intensivist is prompted to determine whether the R to S interval is greater than 100 MS in any one precordial lead **2320**. If this criteria is met, the intensivist is prompted that there is probable VT **2322**.

If the R to S interval is not greater than 100 MS in any one precordial lead **2320**, the intensivist is prompted to determine whether there is evidence of atrioventricular dissociation **2324**. If this criteria is met, the intensivist is prompted that there is probable VT **2326**.

Alternatively, if there is no evidence of atrioventricular dissociation **2324**, the intensivist is prompted to determine whether V-1 is negative and V-6 positive and QRS greater than 0.14 mSEC **2328**. If this criteria is met, the intensivist is prompted that there is probable VT **2330**.

If this criteria is not met **2328**, the intensivist is prompted that the situation may represent SVT with aberrancy or underlying bundle branch block **2332**.

Referring to **Figure 41**, the assessment of sedation algorithm of the present invention is illustrated. If an intensivist encounters a need for sedation, he may not be certain of all of the aspects and the timelines that are critical to this particular process. Therefore, the intensivist is lead through a decision support algorithm, which prompts the intensivist to address a number of factors in the process **3100**.

1 The intensivist is prompted initially to go to the Scoring section of the algorithm **3100**.

2 The intensivist is prompted to proceed through a number of scorings **3102** and to first score the
3 patient's alertness with points being allocated in the following manner: asleep/unresponsive=0;
4 responsive to voice=1; and hyperresponsive=2 **3104**.

5 The intensivist is prompted next to score the patient's movement with points being
6 allocated in the following manner: no spontaneous movement=0; spontaneous movement=1; and
7 pulls at lines, tubes, dressings=2 **3106**.

8 The intensivist is prompted next to score the patient's respiration based on whether the
9 patient is mechanically ventilated or spontaneously breathing with points being allocated as
10 subsequently discussed. If the patient is mechanically ventilated, the intensivist is prompted to
11 allocate points in the following manner: no spontaneous ventilation=0; spontaneous ventilations
12 and synchronous with ventilator=1; or spontaneous ventilations with cough or dysynchrony>10
13 percent of breaths=2 **3108**. Alternatively, if the patient is spontaneously breathing, the
14 intensivist is prompted to allocate points in the following manner: respiration rate (RR) <10=0;
15 RR=10-30=1; or RR>30=2 **3108**.

16 The intensivist is prompted next to score the patient's heart rate with points being
17 allocated in the following manner: >20 percent below mean for last 4 hr=0; within 20 percent
18 mean for last 4 hr=1; or >20 percent above mean for last 4 hr=2 **3110**.

19 The intensivist is prompted next to score the patient's blood pressure with points being
20 allocated in the following manner: MAP >20 percent for last 4 hr=0; MAP within 20 percent
21 mean for last 4 hr=1; or MAP >20 percent above mean for last 4 hr=2 **3112**.

1 The intensivist is prompted next to determine the sedation score by the following
2 formula: SEDATION SCORE=alertness + movement + respirations + heart rate + blood
3 pressure 3114. In one embodiment, respiratory rate, heart rate, and BP can be computer linked to
4 monitor data thereby simplifying the sedation scoring assessment. The nursing observations are
5 deemed intuitive and the nursing burden in sedation scoring can be minimal by using this point
6 scoring.

7 ^{sub 43} Referring now to **Figure 41A**, the sedation assessment algorithm description continues.

8 The intensivist is prompted then to continue the sedation assessment by moving to the Pain

9 ~~Assessment section of the algorithm 3116.~~

10 In the Pain Assessment section, the intensivist is prompted to determine whether the
11 patient is conscious, communicative, and acknowledging pain 3118. If this criteria is not met,
12 the intensivist is prompted to determine: whether the sedation score is greater than 2 and the
13 patient: is known to be in pain before becoming uncommunicative; or S/p recent surgery; or
14 having tissue ischemia or infarct; or has wounds; or has large tumor possibly impinging on
15 nerves. If the answer to either of these two questions is YES, the intensivist is prompted to treat
16 for pain 3118. The intensivist is prompted then to continue the assessment by moving to the
17 Delirium Assessment section of the algorithm 3118.

18 In the Delirium Assessment section, the intensivist is prompted to determine whether the
19 sedation score is greater than 2 AND the patient has: day/night reversal with increased agitation
20 at night OR eyes open and "awake" but disoriented; or eyes open and "awake" but pulling at
21 lines, tubes, or dressings OR difficult to sedate prior to ventilator weaning OR paradoxical

1 response to benzodiazepines. If this criteria is met, the intensivist is prompted to consider
2 butyrophenone **3120**.

3 *Sub*
4 *at* Referring to **Figure 42**, the Bolus sliding scale algorithm is illustrated. If an intensivist
5 encounters a need for sedation, the algorithm for which may contain a reference to the bolus
6 sliding scale for midazolam, he may not be certain of all of the aspects which are critical to this
7 scale. Therefore, the intensivist is lead through a decision support algorithm, which prompts the
8 intensivist through the use of the scale **3200**.

9 If lorazepam is less than 0-2 mg IV q 6hr, then the intensivist is prompted to give
10 midazolam 1-2 mg q 5 min until adequately sedated **3202**.

11 Alternatively, if lorazepam equals 2-4 mg IV q 4 hr, then the intensivist is prompted to
12 give midazolam 2 mg q 5 min until adequately sedated **3202**.

13 Alternatively, if lorazepam is greater than 10 mg IV q 4 hr, then the intensivist is
14 prompted to give midazolam 5 mg q 5 min until adequately AND consider fentanyl and/or
15 droperidol or Haldol for synergy despite delirium and pain assessment **3202**.

16 *Sub*
17 *at* Yet another decision support routine is the sedation algorithm. Referring to **Figure 43**,
18 the sedation process decision support algorithm is illustrated. If an intensivist determines that a
19 patient will require sedation, the intensivist may not be certain of all aspects that would be
20 involved in this particular process. Therefore, the intensivist is lead through a decision support
21 algorithm, which prompts the intensivist to conduct a sedation assessment based on: 1) scoring;
22 2) pain; and 3) delirium (see Assessment of Sedation algorithm) **3300**.

Following completion of the sedation assessment process **3300**, the intensivist is
prompted to determine whether the patient is in pain **3302**. If this criteria is met, the intensivist

1 is prompted to administer bolus morphine, fentanyl, other narcotic, start patient controlled
2 analgesic (PCA) or epidural analgesia as indicated 3324. If the patient is not in pain 3302 or
3 after administering bolus morphine, fentanyl, other narcotic, start patient controlled analgesic
4 (PCA) or epidural analgesia as indicated 3324, the intensivist is prompted to determine whether
5 the patient is delirious 3304.

6 *SW*
ab If the intensivist determines that the patient is delirious 3304, he is prompted to
7 administer droperidol 2.5-5 mg q30min prn and that he may consider IV Haldol not to exceed
8 30mg/24hr 3326. If the patient is not delirious or after following the procedures in 3326, the
9 intensivist is prompted to determine whether the patient will need sedation for more than the next
10 24 hours 3306. If the patient will not need sedation for more than the next 24 hours 3306, the
11 ~~process continues as described in Figure 44~~

12 Alternatively, if the patient will need sedation for more than the next 24 hours 3306, the
13 intensivist is prompted to determine whether the sedation score is 8-10 3308. If this criteria is
14 met, the intensivist is prompted to employ the Bolus sliding scale midazolam and increase
15 lorazepam by 20 percent 3328 (see Bolus sliding scale midazolam algorithm – Figure 42).
16 Subsequently, the intensivist is prompted to reassess sedation in 4 hr 3330.

17 If the sedation score is not 8-10, the intensivist is prompted to determine whether the
18 sedation score is greater than or equal to the last Sed Scr after sedative bolus or increase 3310. If
19 this criteria is met, the intensivist is prompted to employ the procedures described above in 3328
20 and 3330.

21 If the sedation score is not greater than or equal to the last Sed Scr after sedative bolus or
22 increase 3310, the intensivist is prompted to determine whether four (4) or more midaz boluses

1 have been given since last q4hr assessment **3312**. If this criteria is met, the intensivist is
2 prompted to employ the procedures described above in **3328** and **3330**.

3 Alternatively, if less than four (4) midaz boluses have been given since last q4hr
4 assessment **3312**, the intensivist is prompted to determine whether the patient is adequately
5 sedated **3314**. If this criteria is not met, the intensivist is prompted to employ the procedure
6 described in **3328** and **3330**.

7 If the intensivist determines that the patient is adequately sedated **3314**, the intensivist is
8 prompted to determine whether the sedation score is 0-2 **3316**. If this criteria is met, the
9 intensivist is prompted to decrease lorazepam by 20 percent **3332** and reassess sedation in 4 hr
10 **3334**.

11 Alternatively, if the sedation score is not 0-2 **3316**, the intensivist is prompted to
12 determine whether the sedation score is less than or equal to the last Sed Scr after sedative
13 decrease **3318**. If this criteria is met, the intensivist is prompted to employ the procedure
14 described in **3332** and **3334**.

15 If the sedation score is not less than or equal to the last Sec Scr after sedative increase
16 **3318**, the intensivist is prompted to determine whether the patient is clinically oversedated **3320**.

17 If the patient is clinically oversedated **3320**, the intensivist is prompted to employ the procedure
18 described in **3332** and **3334**. If the patient is not clinically oversedated **3320**, the intensivist is
19 prompted to reassess sedation in 4 hr **3322**.

20 *Sub*
AT Referring to **Figure 44**, the short term sedation process decision support algorithm of the
21 present invention is illustrated. If an intensivist determines that a patient will not require
22 sedation past the next 24 hour period, the intensivist may not be certain of all aspects that would

be involved in this particular process. Therefore, the intensivist is lead through a decision support algorithm, which prompts the intensivist to conduct a sedation assessment based on: 1) ~~scoring, 2) pain, and 3) delirium (see Assessment of Sedation algorithm) 3100.~~

Following completion of the sedation assessment process **3100**, the intensivist is prompted to decrease lorazepam by 20 percent from baseline per day **3102**. The intensivist is prompted next to determine whether the patient is in pain **3104**. If this criteria is met, the intensivist is prompted to administer bolus morphine or fentanyl **3122**. If the patient is not in pain or after administering bolus morphine or fentanyl **3122**, the intensivist is prompted to determine whether the patient is delirious **3106**.

If the intensivist determines that the patient is delirious, he is prompted to administer droperidol 2.5-5 mg q30min prn **3124**. If the patient is not delirious or after administering droperidol **3124**, the intensivist is prompted to determine whether the sedation score is 8-10 **3108**.

If this criteria is met, the intensivist is prompted to employ the Bolus sliding scale midazolam (see Bolus sliding scale midazolam algorithm) and begin midazolam infusion or begin propofol 1-2 mg/kg bolus and 5-50 mcg/kg/min infusion **3126**. Subsequently, the intensivist is prompted to reassess sedation in 1 hr **3128**.

If the sedation score is not 8-10, the intensivist is prompted to determine whether the sedation score is greater than or equal to the last Sed Scr after sedative bolus or increase **3110**. If this criteria is met, the intensivist is prompted to employ the procedures described above in **3126** and **3128**.

If the intensivist determines that the sedation score is not greater than the last sedation

1 score after sedative bolus or increase **3110**, the intensivist is prompted to determine whether the
2 patient is adequately sedated **3112**. If this criteria is not met, the intensivist is prompted to
3 employ the procedures described above in **3126** and **3128**.

4 If the intensivist determines that the patient is adequately sedated **3112**, he is prompted to
5 determine whether the sedation score is 0-2 **3114**. If this criteria is met, the intensivist is
6 prompted to determine if the patient has been sedated for more than 72 hours **3130**. If the
7 patient has not been sedated for more than 72 hours **3130**, the intensivist is prompted to hold
8 midazolam or propofol and hold or decrease lorazepam by 50 percent **3132**. The intensivist is
9 prompted subsequently to reassess sedation in 1 hour **3134**.

10 Alternatively, if the intensivist determines that the patient has been sedated for more than
11 72 hours **3130**, the intensivist is prompted to hold midazolam or propofol and decrease
12 lorazepam by 20 percent per day **3136**. The intensivist is prompted subsequently to reassess
13 sedation in 1 hour **3134**.

14 Alternatively, if the intensivist determines that the sedation score is not 0-2 **3114**,
15 the intensivist is prompted to determine whether the sedation score is less than or equal to the
16 last sedation screening after sedative decrease **3116**. If this criteria is met, the intensivist is
17 prompted to determine whether the patient has been sedated for more than 72 hours and to
18 follow the procedures described above in **3130**.

19 If the intensivist determines that the sedation score is not less than or equal to the
20 last Sed Scr after sedative decrease **3116**, the intensivist is prompted to determine whether the
21 patient is clinically oversedated **3118**. If this criteria is met, the intensivist is prompted to
22 determine whether the patient has been sedated for more than 72 hours and to follow the

1 procedures described above in **3130**. If this criteria is not met, the intensivist is prompted to
2 reassess sedation in 1 hr **3120**.

3 *Sub as* Referring to **Figure 45**, the respiratory isolation decision support algorithm is illustrated.

4 If an intensivist determines that there may be a need for respiratory isolation, the intensivist may
5 not be certain of all aspects that would be involved in this process. Therefore, the intensivist is
6 lead through a decision support algorithm which prompts the intensivist to determine the need
7 for respiratory isolation based upon: a) clinical assessment; and/or b) smear/culture findings

8 ~~3500~~

9 Pursuing the clinical assessment branch of the decision support algorithm, the intensivist
10 is prompted to determine whether the patient has known mTB (mycobacterium tuberculosis)

11 **3502**. If this criteria is met, the intensivist is prompted to determine whether the patient has been
12 compliant with their medications for over 2 weeks and is clinically responding **3512**. If the
13 patient has not been compliant with their medications for over 2 weeks and is not clinically
14 responding **3512**, the intensivist is prompted that isolation is required **3514**. If the patient has
15 been compliant with their medications and is clinically responding **3512**, the intensivist is
16 prompted that no isolation is required **3516**.

17 Alternatively, if the patient does not have known mTB **3502**, the intensivist is prompted
18 to determine whether the patient has known mycobacterial disease other than TB **3504**. If this
19 criteria is met, the intensivist is prompted to determine whether the patient has new CXR (chest x
20 ray) findings and symptoms (cough 2 weeks, fever, weight loss) **3518**. If the patient does not
21 have new CXR findings and symptoms **3518**, the intensivist is prompted that no isolation is

1 required **3520**. If the patient does have new CXR findings and symptoms **3518**, the intensivist is
2 prompted that isolation is required **3522**.

3 If the patient does not have known mycobacterial disease other than TB **3504**, the
4 intensivist is prompted to determine whether there is a new cavitary lesion on CXR **3506**. If this
5 criteria is met, the intensivist is prompted that isolation is required **3524**.

6 Alternatively, if there is no new cavitary lesion on CXR **3506**, the intensivist is prompted
7 to determine whether there are pulmonary infiltrates or whether the patient is HIV (human
8 immunodeficiency virus) positive **3508**. If this criteria is not met, the intensivist is prompted that
9 no isolation is required **3510**. If this criteria is met, the intensivist is prompted to determine
10 whether the patient has new CXR findings and symptoms (cough 2 weeks, fever, weight loss)
11 **and** at high risk: 1) known mTB exposure; 2) homeless; 3) prisoner; 4) travel to area with multi-
12 drug resistant TB **3526**. If this criteria is met, the intensivist is prompted that isolation is
13 required **3528**. Alternatively, if this criteria is not met, the intensivist is prompted that no
14 isolation is required **3530**.

15 Pursuing the smear/culture branch of the decision support algorithm **3500**, the intensivist
16 is prompted to determine whether the AFB (acid-fast bacilli) smear is positive **3532**. If the AFB
17 smear is not positive, the intensivist is prompted that: no isolation is required; await culture
18 results; if culture negative, no isolation required; if culture positive and patient has mycobacterial
19 disease other than TB (MOTT no isolation is required; if the culture is positive and the patient
20 does not have MOTT consult ID **3534**.

21 Alternatively, if the AFB smear is positive, the intensivist is prompted to determine
22 whether the patient has known mycobacterial disease other than TB **3536**. If this criteria is not

1 met, the intensivist is prompted that isolation is required 3538. If this criteria is met, the
2 intensivist is prompted: to isolate until results of NAP test are in; if mTB positive isolate the
3 patient; if no mTB, no isolation is required 3540.

4 *sum*
5 Referring to **Figure 47**, the empiric meningitis treatment decision support algorithm of
6 the present invention is illustrated. If the intensivist is treating a patient for meningitis, the
7 intensivist is prompted to answer a series of queries by the system to properly address
8 medication and dosage. First, the intensivist is prompted to determine whether the patient has
9 suffered a head trauma or undergone neurosurgery 3700. The answer to this question is input 1
10 to **table x** below. The intensivist is next prompted to determine whether the patient is allergic to
11 penicillin or is from an area where penicillin resistant staphylococcus pneumoniae is prevalent
12 **3702**. The answer to this question becomes input 2 to **table x** below. The intensivist must also
13 determine whether the patient is immunocompromised **3704**, and the answer becomes input 3 to
14 **table x** below. The intensivist determines if the patient is over fifty years of age **3706**, with the
15 answer being input 4 in **table x** below. Lastly, the intensivist is prompted to determine whether
16 the patient has altered mental status **3708**, and the answer becomes input 5 in **table x** below. The
17 inputs to each of these prompts **3702, 3704, 3706, 3708** is compared to a dosage database
18 according to the **Table 5** below.

Table 5: Meningitis Input-Output Table

71010

Input	Combinations	Output
1	1 = yes 2 = no	A) vancomycin 1.5 – 2 gm IV q 12h + ceftazidime 2gm IV q 8 hr or cefapime 2gm IV q 8 hr
2	1 = yes 2 = no	B) vancomycin 1.5 – 2 gm IV q 12h

		+ aztreonam 0.5 – 2 gm IV q 6-8 hr
3	1 = no 2 = no 3 = no 4 = yes	<u>ampicillin 2 gm IV q 4h</u> + ceftriaxone 2 gm IV q12 cefotaxime 2 gm IV q 6 h
4	1 = no 2 = no 3 = no 4 = no	<u>ceftriaxone 2 gm IV q 12 hr</u> or cefotaxime 2 gm IV q 6 hr
5	1 = no 2 = no 3 = yes	<u>ampicillin 2 gm IV q 4 hr</u> + ceftazidime 2 gm IV q 8 hr or cefipime 2 gm IV q 8 hr
6	1 = no 2 = yes 3 = no 4 = yes	<u>vancomycin 1.5 – 2 gm IV q 12 hr</u> + chloramphenicol 1 gm IV q 6 hr
7	1 = no 2 = yes 3 = no 4 = no	
8	1 = no 2 = yes 3 = yes	
9	5 = yes to inputs 3-8	add to output consider acyclovir 10 mg/kg IV q 8h

In the Meningitis Input-Output Table, possible combinations of the five inputs are listed. For the conditions manifested in the patient, different drugs and dosages will be required. The proper treatment for each combination is listed in the output column of **Table x**. After the algorithm runs the comparison, the output is displayed on the computer screen, prompting the intensivist with the proper treatment 3712.

Referring to **Figure 48**, the ventilator weaning decision support algorithm of the present invention is illustrated. The ventilator weaning decision support algorithm is used to determine whether an intensive care unit patient can return to breathing unassisted, and discontinue use of a

ventilator. Such a determination requires evaluation of the patient by the intensivist over the
~~course of several days.~~

To begin the decision process of whether to wean a patient from ventilator use, the intensivist is prompted to conduct daily screening, preferably during the hours of 06:00 a.m. to 10:00 a.m. **3800**. The daily screen prompts the intensivist to determine whether: the patients P/F ratio is greater than 200, the patient's positive end-expiratory pressure (PEEP) is less than or equal to 5, whether cough suctioning has been adequate and/or spontaneous, infusions with vasopressors have been necessary, and continuous infusions of sedatives or neuromuscular blocking agents have been necessary **3800**. If all conditions **3802** are answered no, the intensivist is directed by the system to repeat the daily screen **3805** the following morning. If all the conditions of the daily screen are met **3802**, the intensivist is prompted to perform additional tests.

If the patient has satisfied the daily screen, the intensivist is next directed to conduct a rapid shallow breathing test **3804**. To perform the test, the intensivist is directed to change the ventilator setting to continuous positive airway pressure (CPAP) less than or equal to 5. In other words, there is no intermittent mandatory ventilation or pressure support provided for the patient.

The patient is given one minute to reach a steady state of breathing. Then the intensivist measures the ratio of breaths per minute to tidal volume (f/V_T). The intensivist next is prompted to determine whether the patient's f/V_T is less than or equal to 105 breathes per minute **3806**. If the patient's f/V_T is greater than 105 breathes per minute, the intensivist is prompted to return to performing daily screening the following morning **3808**.

If the patient's f/V_T is less than or equal to 105 breathes per minute, the intensivist is next

1 directed to perform a trial of spontaneous breathing. Here, the intensivist can either insert a T-
 2 Piece in the patient's airway or reduce the patient's CPAP to less than or equal to 5 over the
 3 course of two hours. The intensivist is prompted to observe the patient periodically in order to
 4 evaluate if the patient is breathing without assistance **3810**. The intensivist is prompted to
 5 perform a periodic assessment by determining whether: the patient's breathing characteristics
 6 are greater than 35 breaths per minute for 5 minutes, or SpO₂ is less than 90%, or the patient's
 7 Heart Rate (HR) is greater than 140, or HR deviates from the baseline breathing rate by more than
 8 20%, or the patient's SBP is outside the range of 90 to 180. If any of the conditions are met, the
 9 intensivist is directed by the system to terminate ventilator weaning **3812**. If the conditions are
 10 not met, the patient is further assessed.

11 In further assessment, the intensivist is prompted to determine whether the patient has
 12 been able to breathe spontaneously for two hours, keep a clear airway, and does not have any
 13 procedures scheduled within twenty-four hours that would require the patient to be intubated
 14 **3814**. If the patient meets all of these criteria **3814**, the intensivist is notified by the system that
 15 the patient may be extubated **3816**. If the patient does not meet one or more of the criteria **3814**,
 16 the intensivist is prompted to perform steps for progressive weaning **3818**.

17 Referring to **Figure 48A**, the ventilator weaning decision support algorithm of the
 18 present invention is further illustrated. The intensivist, at his or her discretion may choose
 19 either T-piece progressive weaning or pressure support progressive weaning. In order to perform
 20 T-piece progressive weaning, the intensivist is directed to repeat the trial of spontaneous
 21 breathing (as previously described **3810**). The intensivist can either insert a T-piece in the
 22 patient's airway or reduce the patient's CPAP to less than or equal to 5 over the course of two

hours. The intensivist is prompted to perform periodic assessment of the patient by either a two

~~hour or 30 minute trial 3820.~~

In order to perform pressure support progressive weaning, the intensivist is first prompted to observe whether the patient's pressure support (PS) rating is equal to eighteen plus or minus the positive end-expiratory pressure (PEEP). Next, the intensivist is directed by the system to regulate the pressure values in order to keep the patient's respiratory rate (RR) between twenty and thirty. Next, the intensivist is directed by the system to decrease the patient's pressure support by 2-4 centimeters of water two times per day. Once the patient maintains pressure support for at least two hours, the intensivist is prompted to further pursue extubating the patient 3822.

After either T-Piece progressive weaning 3820 or pressure support progressive weaning 3822, the intensivist is next prompted to perform a periodic assessment of the patient. Here, the intensivist must determine whether whether: the patient's breathing characteristics are greater than 35 breaths per minute for 5 minutes, or SpO₂ is less than 90%, or the patient's HR is greater than 140, or HR deviates from the baseline breathing rate by more than 20%, or the patient's SBP is outside the range of 90 to 180. Where the patient meets any of these criteria, the intensivist is prompted to terminate weaning. If the patient meets none of these criteria, the intensivist is prompted to further assess the patient's ability to breath spontaneously 3824.

In further assessment, the intensivist is prompted to determine whether the patient has been able to breathe spontaneously for two hours, keep a clear airway, and does not have any procedures scheduled within twenty-four hours that would require the patient to be intubated 3826. If the patient meets all of these criteria 3814, the intensivist is notified by the system that

1 the patient may be extubated 3828. If the patient does not meet one or more of the criteria 3826,
2 the intensivist is directed by the system to allow the patient to rest for at least twelve hours at
3 A/C, the last level of pressure support the patient achieved 3830. The intensivist is prompted to
4 resume progressive weaning the following day 3832.

5 Referring to **Figure 49**, the Warfarin Dosing Algorithm of the present invention is
6 illustrated. The intensivist is first prompted to give the initial dose and determine subsequent
7 dosage each day 3900. When the intensivist determines subsequent dosage, he is first prompted
8 to determine the patient's target INR 3902. If the patient's target INR ranges from 2.0 to 3.0, the
9 intensivist is prompted by the system to make further determinations relevant to dosage. The
10 intensivist is directed by the system to determine whether the patient is taking drugs that effect
11 prothrombin time 3904, the baseline INR value 3906, and whether rapid anticoagulation is
12 required 3908. Each answer is assigned a point value, and the total points are tabulated. If the
13 point value is greater than one, the system refers to the 10 milligram load target database for
14 dosing. If the point value is less than one, the system refers to the 5 milligram load target
15 database for dosing 3910.

16 At the initial INR determination 3902, if the patient's INR was initially between 1.5 and
17 2.0, the system refers to the 5 milligram load target database for dosing. If the patient's INR was
18 initially between 3.0 and 4.0, the system refers to the 10 milligram load target database for
19 dosing 3910. Next the intensivist is prompted to enter the day of treatment 3912 and the
20 patient's INR 3914. Depending on whether the system has been directed to the 5 milligram load
21 target or the 10 milligram load target, a comparison is run 3916 according to the following
22 tables.

5 mg Load Target INR 1.5-2.0

day	<1.5	1.5-2	2-2.5	>2.5
2	5	1.25 - 2.5	0	0
3	5-7.5	1.25 - 2.5	0 - 1.25	0
4	10- (Check to see whether pt has received vit K)	1.25 - 2.5	0 - 1.25	0
5	10 (Check to see whether pt Has received vit K)	2.5 - 5	0 - 2.5	0 - 1.25
6	15 Obtain hematology consultation.	2.5 - 5	1.25 - 2.5	0 - 1.25

10 mg Load Target INR 3.0-4.0

day	<1.5	1.5-2	2-2.5	2.5-3	>3
2	10	7.5 - 10	5-7.5	2.5-5.0	0-2.5
3	10 -15	7.5 - 10	5-7.5	2.5 - 5	2.5-5
4	10 -15 (Check to see whether pt has received vit K)	7.5 -12.5	5 - 10	5-7.5	2.5-5
5	15 (Check to see whether pt has received vit K)	10 - 12.5	7.5-10	5 - 7.5	2.5-5
6	15-20 obtain hematology consultation.	10 - 15	7.5-12.5	5 - 10	5-7.5

The appropriate dosage and instructions is displayed on the computer screen to the intensivist 3918.

1
2
3 Referring to **Figure 51**, the heparin-induced thrombocytopenia (HIT) decision support

4 algorithm of the present invention is illustrated. The intensivist is prompted to observe whether

5 the patient's platelet count has dropped 50% or more over seventy-two hours while being treated

6 with heparin, and whether any other obvious causes of platelet reduction might be present **4100**.

7 If such a drop has not occurred, the intensivist is notified by the system that the patient most

8 likely does not have HIT, but monitoring of the platelet count should continue **4102**. If the

9 patient's platelet count has drastically dropped, the intensivist is prompted to determine whether

10 the patient has been treated with heparin for more than three days **4104**. Regardless of the

11 answer, the intensivist is next prompted to determine if the patient has been treated with heparin

12 in the preceeding three months **4106**. If the patient has not received heparin in the preceeding

13 three months, the intensivist is notified by the system that HIT is not likely to be the cause of the

14 platelet drop. The intensivist is also prompted to monitor platelet count for infection or other

15 thrombocytopenia-causing drugs, and to consider stopping heparin therapy if the platelet count

16 ~~drops below 50,000 per cubic millimeter **4108**.~~

17 If the patient has received heparin in the last three days **4104**, the intensivist is further

18 prompted to look for signs of thrombosis, or blood clotting **4110**. If the patient shows signs of

19 thrombosis, the intensivist is notified by the system that the patient is likely to have HIT.

20 Accordingly, the intensivist is prompted to stop administering heparin and flush any drug

21 administration equipment that would contain heparin traces. The intensivist is also provided

22 instructions by the system to treat a patient still requiring anticoagulation treatment with alternate

drugs and methods **4112**.

Where the patient does not show signs of thrombosis 4110, the intensivist is prompted to check for heparin resistance 4114. Signs of heparin resistance include inability to hold aPTT though heparin doses have been increase. If the patient shows signs of heparin resistance, the intensivist is prompted to consider stopping heparin treatment and to consider treating a patient still requiring anticoagulation treatment with alternate drugs and methods 4116. If the patient does not show signs of heparin resistance, the intensivist is notified by the system that the patient possibly has HIT. The intensivist is accordingly prompted to continue monitoring for thrombosis, consider infection or other drugs that cause thrombocytopenia, and to consider stopping heparin therapy if the platelet count drops below 50,000 per cubic millimeter 4118

Results

The structure of the present invention and its efficacy have yielded striking results in practice. In a research setting, deployment of certain rudimentary aspects of the present the invention designed to experimentally test the approach described and developed in detail above, yielded unprecedented improvements in clinical and economic outcomes: 50% improvement in severity adjusted mortality, 40% improvement in clinical complication rates, 30% improvement in ICU length of stay, and 30% improvement in overall ICU cost of care.

A system and method of remote monitoring of ICU's and other healthcare locations has been shown. It will be apparent to those skilled in the art that other variations of the present invention are possible without departing from the scope of the invention as disclosed. For example, one can envision different ratios of command center/remote location to ICU's, other decision support algorithms that would be used by intensivists, other types of remote monitoring



1 of not only ICU's but other types of hospital functions as well as industrial functions where
2 critical expertise is in limited supply but where that expertise must be applied to ongoing
3 processes. In such cases a system such as that described can be employed to monitor processes
4 and to provide standardized interventions across a number of geographically dispersed locations
5 and operations.

6

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